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A COMPARISON OF COMMERCIAL EXPRESS AND THE DEFENSE TRANSPORTATION SYSTEM IN THE MOVEMENT OF REPARABLE ASSETS WITHIN WESTERN PACAF

THESIS

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THESIS

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Corey M. Vickers

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List of Acronyms

AB	Air Base
AFLC	Air Force Logistics Command
AFMC	Air Force Materiel Command
AFMCR	Air Force Materiel Command Regulation
ATAC	Advanced Traceability and Cargo
BOS	Base Operating Support
CONUS	Continental United States
CRAF	Civil Reserve Air Fleet
DoD	Department of Defense
DTS	Defense Transportation System
ETADS-FEP	Enhanced Transportation Automated Data System - Front End Processor
GAO	General Accounting Office
HQ PACAF	Headquarters Pacific Air Forces
HQ PACAF/LG	Headquarters Pacific Air Forces Director of Logistics
HQ PACAF/LGT	Headquarters Pacific Air Forces Director of Transportation
ITV	In-Transit Visibility
LL/2LM	Lean Logistics/Two-Level Maintenance
MAJCOM	Major Command
NPR	National Performance Review
NSN	National Stock Number

OO-ALC	Ogden-Ordnance Air Logistics Center
PACAF	Pacific Air Forces
PLSC	PACAF Logistics Support Center
RDD	Required Delivery Date
SCP	Support Center Pacific
TP	Transportation Priority
USAF	United States Air Force
WESTPAC	Western Pacific Air Forces
WWX	World Wide Express

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Abstract

This study was initiated by the assertion that it was taking a greater amount of time to transport assets from Support Center Pacific (SCP) to its Western Pacific Air Forces (WESTPAC) customers (Misawa AB Japan, Yokota AB Japan, Kunsan AB Korea, and Osan AB Korea) than it was taking to transport similar assets to the same locations from a CONUS repair facility. These delivery times include the total time it takes a reparable asset to be transferred from a repair facility (consignor) to the user (consignee). Pacific Air Forces (PACAF) has proposed using commercial express freight carriers to transport reparable assets between SCP and its customers may reduce the amount of time it takes to move reparables between the WESTPAC locations. Lengthy delivery time severely hampers the most important aspect of having a regional repair facility such as SCP, rapid repair response for key reparable items. Therefore, PACAF became determined to derive delivery times of shorter duration than those achievable from other sources of repair.

This study determines whether or not the current mean delivery times from SCP to WESTPAC installations are of greater duration than mean delivery times of shipments from CONUS repair facilities. Also, an assessment of the use of commercial express transportation rather than the Defense Transportation System (DTS), is made to determine whether or not such a change in operating procedures will reduce average delivery times.

Data was collected for shipments between CONUS repair facilities and WESTPAC installations as well as between SCP and the same installations. From these data sets mean delivery times were derived and compared using a large sample *z* test. Additionally, the means from the samples of data for shipments between SCP and its customers using the DTS were compared to the means from the samples of data collected when a commercial express freight carrier was used using the same test statistic.

It was found that, in all cases it took a greater amount of time to move assets between CONUS repair facilities and WESTPAC installations than between SCP and the same installations. It was also found that the commercial express carrier was able to provide a more rapid delivery than the DTS. These findings provide only knowledge about the delivery times associated with these routes and these carriers and should be followed by other analyses.

A COMPARISON OF COMMERCIAL EXPRESS AND THE DEFENSE TRANSPORTATION SYSTEM IN THE MOVEMENT OF REPARABLE ASSETS WITHIN WESTERN PACAF

I. Background and Problem Presentation

Introduction

In the event that an Air Force Major Command (MAJCOM) requires faster response for the repair of mission essential reparable assets, Air Force Materiel Command Regulation 66-36 (DRAFT) provides for the establishment of a regional repair facility. Specifically, these repair facilities are founded on the premise that they will "improve combat capability within the overseas theater" (AFMCR 66-36 (DRAFT), 1996:4). The purpose of these facilities is twofold: they are designed to off-load certain work from the depots in the continental United States (CONUS) and, most importantly, they are designed to provide very rapid response for repair of specific reparable items within a certain region. Just such a facility is located at Kadena Air Base, Japan and is referred to as Support Center Pacific (SCP). Pacific Air Forces (PACAF) established this facility in 1984 to "provide the PACAF theater with depot level support on critical avionics and heavy industrial assets and equipment" (Carney and Morris, 1996:1).

In December of 1996, Brigadier General Robert G. Jenkins, Director of Logistics, (HQ PACAF/LG) directed Colonel Wang (HQ PACAF/LGT) to "improve

transportation times to and from the SCP." This direction came as a result of General Jenkins' understanding that it was taking a greater amount of time to transport assets from SCP to its Western Pacific Air Forces (WESTPAC) customers (Misawa AB Japan, Yokota AB Japan, Kunsan AB Korea, and Osan AB Korea) than it was taking to transport similar assets to the same locations from a CONUS repair facility. These delivery times include the total time it takes a reparable asset to be transferred from a repair facility (consignor) to the user (consignee). This process will be further discussed later in this research. A cursory analysis of the pertinent logistics indicators revealed the delivery times shown in Table 1 (Bollinger, 1996).

Table 1: Initial Delivery Time Assessment

ROUTE	MEAN DELIVERY TIME
SCP to Misawa AB, Japan:	6.5 days at the latest point on a slightly upward trend
SCP to Yokota AB, Japan:	3.3 days at the latest point on an overall upward trend
SCP to Kunsan AB, Korea:	5.9 days at the latest point in an overall downward trend
SCP to Osan AB, Korea:	7.8 days at the latest point in an overall upward trend

The aggregated mean delivery time between SCP and its WESTPAC customers turned out to be 5.1 days. Comparatively, delivery times from CONUS repair

facilities to the WESTPAC wings averaged to 4.1 days (Bollinger, 1996). As this previous analysis relied upon imperfect data and limited analytical control it was believed by Headquarters PACAF (HQ PACAF) personnel that further research of these times should be performed.

It would seem obvious that, given that SCP has a much closer proximity to the WESTPAC installations, delivery times should be of a shorter duration from SCP than delivery times between the CONUS repair facilities and the same bases. In fact, in their published history document, the SCP boasts that, "being centrally located on Okinawa, Support Center Pacific is only two hours by air from any of the PACAF customers" (Carney and Morris, 1996:3). This geographical advantage that SCP has over CONUS depots, in light of Bollinger's 1996 study, clearly indicates a severe disparity in the reparable asset transportation process between SCP and its customers. Therefore, HQ PACAF set about the task of correcting this incongruity and this research is a contribution to the concerted effort to derive an explanation to the disparate delivery times.

Problem Presentation

Brigadier General Jenkins, HQ PACAF/LG, proposed that mean delivery times from SCP to WESTPAC installations could be reduced to beneath a ceiling of 2.5 days. In order to achieve this goal, PACAF has proposed using commercial express freight carriers to transport reparable assets between SCP and its customers. Due to the fact that lengthy delivery time severely hampers the most important aspect of having a regional repair facility, rapid repair

response for key reparable items, it is incumbent on PACAF to derive delivery times of shorter duration than those achievable from other sources of repair.

Problem Statement. This study determines whether or not the current mean delivery times from SCP to WESTPAC installations are of greater duration than mean delivery times of shipments from CONUS repair facilities. Also, an assessment of PACAF's proposed solution, the use of commercial express transportation rather than the Defense Transportation System (DTS), is made to determine whether or not such a change in operating procedures will reduce mean delivery times.

Support Center Pacific

Support Center Pacific, or more formally known as Ogden-Ordnance Air Logistics Center (OO-ALC) Detachment 35, was established in 1984 as a result of Air Force Logistics Command's (AFLC) Pacer Crescent Plan (Wright, 1997). "AFLC's goal was to gradually establish a repair capability for items with high failure rates, where the payoff in increased theater war-fighting potential would be the greatest" (Haines, 1988: 32). On a more fundamental level, SCP was established to augment the PACAF Logistics Support Center (PLSC), the military backshop under the three-level maintenance policy of the time, "with a cadre of depot repair technicians" (Carney and Morris, 1996:1). Since 1984, SCP has proved itself capable of achieving the objective set by its parent command. This is evidenced by the fact that aircraft wings within PACAF can boast some of the highest mission capable rates in the active fleet. Other than repair assistance,

SCP also offers engineering support for the various weapons systems of the theater as well as on-site maintenance support. Currently, SCP provides these various depot level services to its PACAF customers as well as customers from other branches of the Department of Defense (DoD). It should be noted that any authorization to repair specific reparable assets SCP receives then precludes WESTPAC wings from requesting such repairs from other sources. As such, only those items not repaired by SCP are delivered to CONUS repair facilities for repair.

Additional Background Information

The armed services have been in an era of force reduction since the end of Operations Desert Shield and Desert Storm, particularly in light of the collapse of the Soviet Union and the ensuing reality of fiscal constraints. What forces to reduce, to what extent, and by what means continue to be topics of great debate at every level of the U.S. government. What remains true is the fact that direction has come from the President and Vice President for government agencies to operate in the most efficient and effective manner possible.

The executive direction is embodied in recommendations, made by Vice President Gore, to President Clinton after the President-directed 1993 National Performance Review (NPR). This study, and the subsequent recommendations, were part of a movement by the U.S. government "to make government work better and cost less" (National Performance Review, 1993). President Clinton's NPR is just one of the many government studies and efforts to streamline and

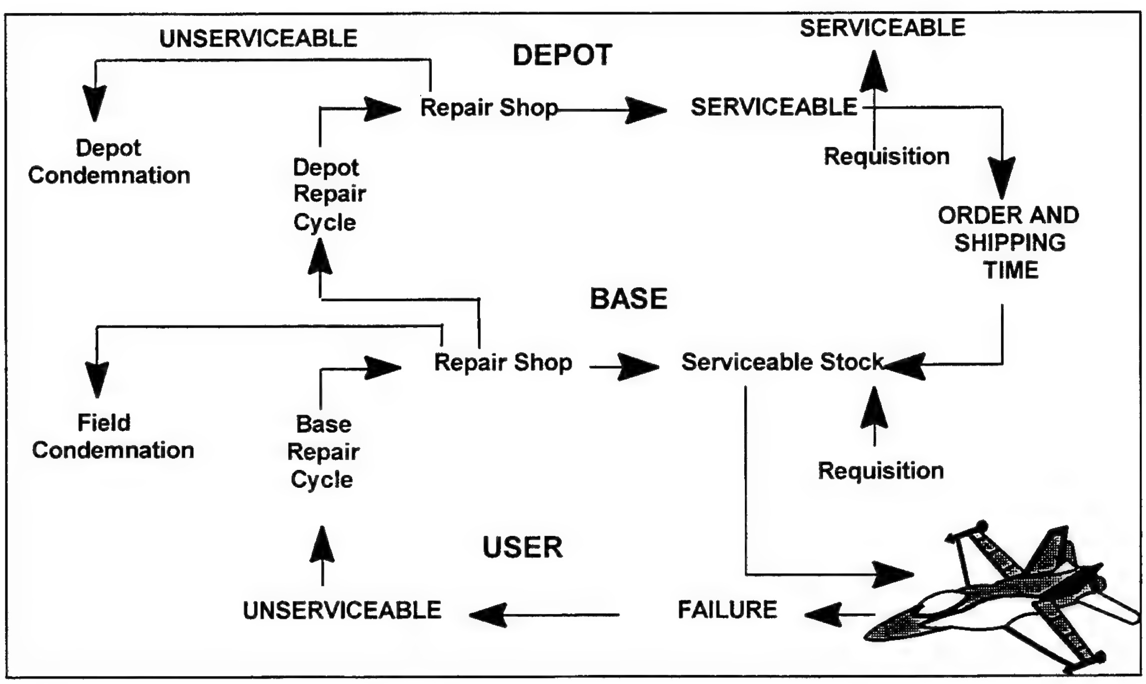
improve the quality of government products and services. With senior government attention and a shrinking budget, the NPR has become a catalyst for change within the rank and file of the military.

Spawned by a multitude of things such as the fall of the Soviet Union, tabescent budgets, and a growing public sentiment that a large standing military is unnecessary, the armed forces have been pursuing modifications to force structure. This has led to the myriad programs specifically designed to analyze and reengineer military processes. Quality Air Force, Lean Logistics, and Two-Level Maintenance are but a few of these programs fundamentally conceived to effectuate best business practices from the commercial sector. The manner about which these processes are modified is intended to bring about the leaner, more efficient, and more effective fighting force demanded by the public at large. In order to draw down to this lean force, great consideration must be afforded the method by which some processes are maintained as organic military functions, albeit not unscathed by process modifications, and others are either turned over to private firms or done away with altogether. It is to this end that PACAF has decided to perform a thorough analysis of the costs and benefits associated with modifying the system by which reparable assets are transported between SCP and its customers. In the end, the goal is to define the best system, both from the standpoint of effect on mission readiness as well as the overall costs.

The Reparable Asset Pipeline

"Reparables are defined as those items that may be repaired or reconditioned and returned to a serviceable condition for reuse" (Christensen and Ewan, 1985:1). The reparable asset pipeline used by the United States Air Force (USAF) is the logistics process by which reparable items are transported from a using unit to a repair center, repaired or reconditioned, and returned to the using unit. This process is composed of six major steps: 1) base processing; 2) reparable in-transit; 3) supply-to-maintenance; 4) shop flow; 5) serviceable turn-in; and 6) order and ship time. Figure I.1 schematically depicts the reparable asset pipeline.

Figure 1: Reparable Asset Pipeline



As can be seen by the above figure, the reparable asset pipeline is composed of two major portions: repair actions occurring at base level and repair actions that require depot level attention. This research deals specifically with those reparable assets leaving the base level for repair at a depot level facility.

Specific actions take place at every step. The base processing step begins when an asset is determined to not be repairable at the base level. Once this determination has been made, the asset is then transferred from the base level maintenance function to the base level supply function where a request is made of the item manager for disposition instructions. If the part is to be repaired or reconditioned it is then picked and packed by the supply function and transferred to the base level transportation function. Once the part arrives at transportation the reparable in-transit step of the reparable asset pipeline begins. During this step the asset is physically prepared for movement, a carrier is scheduled, the cargo is loaded onto the carrier's vehicle, and the actual movement of the asset to the depot level repair location. When the reparable arrives at the depot repair location the supply-to-maintenance step begins as the part is processed into that location's supply computer system. After the asset is posted to the supply computer system it can then be requested by and consequently transported to the depot maintenance function. Once in the depot maintenance function's possession the shop flow step begins. When the asset is repaired the shop flow step ends. The serviceable turn-in step begins once the part has been repaired and includes the time it takes to physically move it

back to the depot level supply function and post it as repaired in the supply computer system.

Quite possibly the longest step in the reparable asset pipeline is the order and ship time. When a customer of the depot repair facility makes a request for a part from the depot order and ship time begins. If the part is on hand at the depot level supply function it is picked and packed by supply, processed through transportation, and transported to the gaining location. The time associated with these steps is incurred by each part that is moved from the depot to a field unit. What extends the time involved with this step is when an asset is not on hand at the depot level supply function. In this case, other than the above mentioned time incurred, there will be the additional time associated with turning a repaired asset out of the maintenance process. This research is specifically concerned with the portion of the order and ship time that does not involve waiting for a reparable to be generated by the maintenance function (Srivastava, 1997:7-9).

Delivery Time. Delivery time, as defined by this research, is the time it takes a serviceable reparable asset to be moved from a depot level repair function to a gaining unit once the item is on hand at the repair facility. The specific processing steps included in the delivery time of a reparable asset for the DTS include the following: 1) the reparable is moved from the supply function at SCP to the Kadena AB, Japan aerial port; 2) the asset is processed through the aerial port and loaded onto an aircraft; 3) it is flown from Kadena AB, Japan to the gaining unit including any intermediate stops the aircraft may make; 4) the reparable is processed through the aerial port at the gaining unit (Kunsan AB,

Korea for instance); and 5) the part is received by the supply function at the gaining unit and processed into the supply computer system.

The process by which the commercial carrier, FedEx, transports assets from SCP to the gaining unit differs from that used by the DTS. First, the assets are picked up by a local carrier at the SCP supply unit and moved via ground transportation to Naha International Airport from where they were flown to Kansai International Airport. From here the assets are moved via FedEx aircraft to their regional hub located in Subic Bay where they are sorted and loaded on other FedEx aircraft for movement to the nation of the gaining installation. As an example, assets would land in Seoul South Korea for shipments traveling to Kunsan or Osan Air Bases. Then the assets would move with a local freight carrier via ground transportation to the final destination supply unit. Delivery time is calculated from the time the asset is picked up at the SCP supply unit until it is delivered to the supply unit of the gaining installation.

Scope

This research analyzes the current status of transit operations from SCP to WESTPAC installations, comparing this operation to that of transit operations from CONUS depots to the same installations. This portion of the research establishes whether delivery times from CONUS depots are of shorter average duration than those from SCP. To effectively conduct this analysis, sample shipment time data was gathered from equivalent periods during the past two years of operations. Data for shipments between CONUS repair facilities and

WESTPAC installations was obtained from the Enhanced Transportation Automated Data System - Front End Processor (ETADS-FEP). ETADS-FEP "is a logistics tracking system utilizing supply and transportation data" and is maintained by personnel at Headquarters Air Force Materiel Command (AFMC) (Rhodes, 1997). Data for shipments between SCP and WESTPAC wings was collected by the HQ PACAF liaison at SCP on the Air Force's official in-transit visibility (ITV) system, Advanced Traceability and Cargo (ATAC).

The second phase of this research analyzes the effects of the use of a commercial express freight carrier, specifically FedEx for test purposes, to transport assets from SCP to WESTPAC installations. This research determines whether there is an advantage, from a transit speed aspect, to the modification of current transit operations to incorporate a commercial express carrier. Again, current shipment data from SCP to its customers is available from ATAC. This data is compared to commercial carrier shipment data gathered from test shipments that were made between March and June of 1997. The commercial carrier shipment data was closely monitored and collated onto a Microsoft Excel spreadsheet by Traffic Management personnel at Kadena AB, Japan.

To effectively limit the amount of data to that reasonable to derive an accurate depiction of current operations versus perspective operations, only data from specific time frames is analyzed. Delivery times for all shipments with a Required Delivery Date (RDD) code of 999 and 777 between SCP and its WESTPAC customers for all months between July 1995 to January of 1997 are used to determine accurate mean delivery times. Data for the same time frame

for all RDD 999 coded shipments between CONUS depots and WESTPAC installations is also analyzed to derive accurate mean delivery times for these routes.

Due to the fact that commercial express carriers have not been utilized for the shipment of priority reparable assets between the concerned locations, tests were conducted by HQ PACAF to generate an impression of exactly what level of service will be provided by that carrier should it be selected for such usage. These tests, which began March 1997 and are ongoing as of this report, specifically involve the shipment of assets between SCP and Kunsan and Osan Air Bases, Korea. A full and detailed description of the various data sets analyzed during this research is provided in Chapter III of this report.

Limitations

Although the approach and method used in the conduct of this research is applicable in most any similar situation, the results of this research are not generalizeable beyond this specific case. As this analysis is focused expressly on the WESTPAC theater of operations, the experimental design is similar to that used by many organizations, both for profit and not, to select appropriate sources for various functions. For these reasons it can be seen that the procedures used to perform this research can be used in future situations where a choice between maintaining a function internal to the organization or outsourcing the function is being considered.

The specificity of the scenario faced by PACAF does not cause the results of this research to lend themselves to wide generalization. As a consequence the limitations of this research include:

- The results of the research should only be linked to those transportation operations conducted between Support Center Pacific and Air Force installations in the Western Pacific region (Misawa AB Japan, Yokota AB Japan, Kunsan AB Korea, and Osan AB Korea).
- The results of the research are only applicable to an assessment of FedEx as a potential source of reparable asset transportation between SCP and its customers.
- The time frame for which data was gathered for analysis prevents the results of this research from being generalized to any situation other than the specific scenario under consideration.

For these reasons this research should only be used to consider whether or not there actually is a discrepancy in the delivery times between SCP and its customers versus those between CONUS depots and WESTPAC customers. Also, the results can only be used to determine if FedEx is an appropriate substitute for DTS, with respect to mean delivery time of reparable assets between SCP and its customers.

Measurement Questions

The following are the specific questions that will be answered as a result of the statistical analysis conducted during this research:

1. What are the current mean delivery times within WESTPAC?
2. What are the current mean delivery times between CONUS repair facilities and WESTPAC installations?
3. Is there a significant difference between the mean delivery times between CONUS repair facilities and WESTPAC installations and the mean delivery times between SCP and its customers?
4. What mean delivery times can be achieved for shipments between SCP and its customers by using a commercial carrier?
5. Are the mean delivery times achievable through the use of the commercial carrier significantly better than those of the current process?

Determining the current delivery times for shipments within WESTPAC as well as those for shipments between CONUS and WESTPAC provides a foundation from which comparisons can be made. These delivery times can be compared to each other to ascertain the validity of the suggestion that it is equally expedient to retrieve an asset from the CONUS depot as it is to retrieve it from SCP. If a difference between these times can be found, an assessment of the magnitude and repercussions of such a difference can then be further analyzed.

If it is found that the delivery times between SCP and its customers actually exceed those times achievable by shipping from CONUS depots, two questions immediately follow. First, one must determine why it takes longer to move reparables within WESTPAC when compared to moving such assets from

the CONUS to WESTPAC. This research will not attempt to answer this question but will rather leave it for other researchers. Secondly, there must be a determination of the best method for modifying current transportation performance to improve reparable asset mean delivery times. As has been suggested, a commercial carrier is one option for potentially reducing mean delivery times for reparable asset shipments from SCP. To substantiate this claim, analyses are made of the current mean delivery times actually attained by a commercial carrier. These are then compared to those of the DTS to ascertain the actuality of accomplishing the task of significantly reducing delivery times within WESTPAC.

General Approach

A parametric statistical analysis is used to address the five measurement questions. The assumptions involved with parametric analysis include: 1) independent samples and 2) approximately normally distributed samples. If these assumptions cannot be fully fulfilled, analysis by parametric means will yield erroneous results and non-parametric statistical methods will have to be employed. Given that the processes involved in this study are very much so independent of each other, the assumption of independence is safe. It cannot readily be assumed that the samples of data are identically distributed without actually testing the numbers involved. The Shapiro-Wilk test for normality will be used to judge the level of similarity between the distributions of the sets of data. If it can be found that the data sets meet the normality assumption, basic

parametric tests such as large sample comparisons of means (z statistics), can then be used to determine which of the methods provide the better service level. If however, the data sets are found to not meet the assumptions, non-parametric tests must be used to make the above determination. All calculations are made using a Microsoft Excel 5.0 spreadsheet.

Management Implications

This research provides the following resources for decision makers:

1. This study offers an assessment of current transportation operations within WESTPAC and determines whether mean delivery times for the pertinent processes are faster or slower than those delivery times from CONUS depots to SCP customers.
2. This research will also determine if commercial express transportation, as a method of transport for reparable assets from SCP to its customers, is faster than the DTS.

Any indication that mean delivery times internal to WESTPAC are of longer duration than those achieved between WESTPAC and CONUS will turn process owners in the direction of performing modifications to the current transportation system. Along those same lines, analysis showing positive results, from a total system perspective, for the utilization of a commercial carrier in the modification of the WESTPAC transportation system would give system managers the flexibility of that option. Any indication that the commercial carrier would not

provide better mean delivery times would cause the exclusion of that carrier as a viable option in the potential modification of the current system.

Chapter Summary

This chapter introduced the reader to the potential condition of less than adequate reparable asset delivery times between Support Center Pacific and Western PACAF installations. Additionally, historical background and the initial purpose of SCP was outlined to provide a sense of the necessity for having a responsive logistics system for Air Force units. A brief sketch of the current movement to reinvent and revitalize government processes and organizations was also provided to introduce the basic impetus for this study. Finally, this chapter outlined the scope, limitations, methods, and potential ramifications if this research.

Sequence of Presentation

The second chapter of this study will thoroughly analyze all of the published literature of subject matter related to this research. The literature review addresses the following questions:

1. Why is logistics process analysis important in today's defense environment?
2. Why is this type of analysis conducted?
3. How is logistics process analysis conducted by both government as well as private sector corporations?

4. Where do logistics process analyses offer significant returns on investment and how do these returns manifest themselves?

To answer these questions information is aggregated from multiple sources including transportation aspects of the Government Performance and Results Act and the National Performance Review. Explicit discussion of the methods used by both government and private sector agencies to elect various functions for outsourcing and how service providers are found is included. To conclude the chapter, a short review of the nature of reparable assets and the reparable asset pipeline is presented, with particular focus on the operations of WESTPAC and SCP.

Chapter III provides the reader with an extensive description of the experimental design that is used to answer the five measurement questions. Also, the chapter discusses the statistical methods which will be employed to analyze the data collected for this analysis. Furthermore, the research data analyzed is described in detail.

Chapter IV gives an exact explanation of the analysis of data and the results provided by the statistical methods outlined in Chapter III. The final chapter gives the conclusions that can be inferred from the analysis, recommendations resulting from the research, and suggestions for further research.

II. Literature Review

Introduction

This chapter provides the reader with an in-depth look at the literature relating to the transfer of government functions to private sector entities. Initially, this review addresses why outsourcing and the privatization of government functions is important today. To answer this question, such topics as the current defense posture as modified from the Cold War era, the need for more efficient and effective conduct of government services, and why commercial firms pursue outsourcing will be discussed. From here it is necessary to determine how privatization and outsourcing efforts are currently being conducted. Outsourcing efforts within the private sector are then compared to the philosophy of privatization pervasive within the DoD. This chapter focuses specifically on logistics functions but the subject matter is generalizeable to other government functions as well. Special emphasis is placed on the DoD costing methods used for outsourcing calculations.

Global Environment

The global environment of today is one of drastic, rapid transformation. Due to political, technological, and economic changes, corporations, governments, and even entire political regimes have been catapulted into an atmosphere heretofore unknown. Until recently, the actuality of a global market

was an impossibility. Now, it is a reality. Never before have companies focused so much attention on the quality of products and yet remained capable of producing at such high rates. To a large extent, these changes in industry have come about through technological advances and enhancements in production and logistics management practices (Tyworth, et. al, 1987:12). Due to these achievements, competition is at its fiercest; "the global economy of the 1990s dictates that companies provide the customer with an ever-widening array of products and services having high levels of quality" (Krajewski and Ritzman, 1996:141).

Improvement Movements in the Private Sector

These global changes have mandated that corporations reassess their business practices to remain viable. To this end, various management philosophies have been espoused, including Total Quality Management, Just-In-Time production, the Theory of Constraints, and, most recently, Business Process Reengineering. Reengineering is specifically designed "'to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed'" (The Change Management Toolkit, 1997:1). The essence of all of these methods is to bring the company's products, services, and procedures into line with its overall purpose or mission as defined by its market. They all generally attempt to reach their goal by reducing costs while simultaneously increasing quality and revenues although the particular focus of each is unique.

The above improvement efforts mandate firms concentrate on the ultimate goal of increased profits. As Prahalad and Hamel state in their article The Core Competence in the Corporation, "It is no longer like the past when a diversified company could simply point its business units at particular markets to become world leaders." Rather than obtusely aim at any market, today's environment demands surgical precision in market selection. Purchase Logic, or understanding precisely what customers want and why they want it, allows a company to decide what business it will pursue (Purchase Logic: The Foundation of Marketing Strategy, 1997:4). To achieve the level of focus needed to compete within this environment, where product offerings are concentrated on specific customers for specific commodities, management must be "free to concentrate on core business activities like manufacturing, marketing or research and development" (The Purchase Logic for Contract Logistics: The Benefits of Outsourcing Distribution, 1997:2). Therefore, companies of today are seeking to concentrate on what they do best (core competencies) and allowing other firms to do for them what they cannot do as well on their own. Fundamentally, this is outsourcing and "was first used by private industry in the 1960's" (Brandt, 1996:5). Both the DoD and private sector firms are seeking the benefits associated with outsourcing but the foundations from which they operate are considerably different.

Instinctively understanding their core competencies, firms have spent decades finding new ways to squeeze greater throughput out of production processes to generate increased profits. This has resulted in numerous

production methods, from Henry Ford's assembly line to Computer-Integrated Manufacturing with industrial robots and computerized numerically controlled machines. What has been witnessed recently is a severe tapering off of breakthrough methods in production management (Goldratt, 1993:27). Additionally, firms have sought to better market their product so as to cultivate an increased demand. Marketing is inherently limited in generating greater profits, as there is an upper limit to the number of people willing to purchase a given product. Also, for each additional dollar in sales generated through better marketing there is only a percentage increase in overall profits. As is the case for all products, for each dollar of product sold, a portion of that dollar pays for the costs associated with producing and distributing that product. What is left after expenses have been paid out of that sales dollar is profit and is normally a small percentage.

As a result of the recently witnessed slowness and minuscule returns of finding more and better ways to increase throughput, and the limitations intrinsic to every market, firms have turned to cost reducing methods to increase overall profits. Profit is "the return received on a business undertaking after all operating expenses have been met."[1] With this definition one can see that a direct change in operating expenses, or costs, yields a direct change in profit. "Logistics costs can exceed 25 percent of each sales dollar at the manufacturing level" (Lambert and Stock, 1993:39). Rather than providing a profit as a percentage of the sales

dollar as increased marketing does, cost reductions effect profits on a one for one basis. Therefore, if one can reduce logistics costs by one dollar one will see a one dollar increase in overall profit. Because logistics is such a large percentage of the costs a business incurs and due to the very small marginal returns available in better production and marketing, logistics is viewed as the last frontier for firms to gain a competitive edge over competition and generate increased profits.

Reasons for Outsourcing

The firm must choose the functions it will perform as well as the functions it will not perform organically to best accomplish its core mission. Deciding which functions a firm will not perform in-house is best assessed by answering why a firm would decide to outsource a function. As enumerated by Dr. William A. Cunningham, Professor of Graduate Logistics Management at the Air Force Institute of Technology, and others, there are four primary reasons for outsourcing: 1) customer service; 2) quality; 3) Business Process Reengineering; and 4) economics and cost (Cunningham, 1997:16). Knowing the gains potentially available in reducing logistics costs, the following reasoning will be developed with a concentration on such services. Customer service is related to the responsiveness and timeliness of a particular function. Corporations may outsource to attain the expertise of a logistics service provider to ensure greater

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responsiveness and timeliness for its product movement. Quality is closely related to customer service because it is designed to provide products on time to the destination in good condition. This category also covers the logistics information, professional customer interfaces, and reduction of service variability a logistics support company can provide. Outsourcing is also used in the current business trend of Business Process Reengineering to help firms focus on their core competency. In summary, outsourcing "takes advantage of economies of scale,... achiev[es] a higher level of specialized service,... and allows focus on core business functions to maximize efficiency and profitability" (Outsourcing Services: The Competitive Advantage, 1997:1). At the heart of all the reasons for outsourcing is profit maximization. The express goal of outsourcing is to find the source of service that provides the needed function with the optimal mix of customer service, quality, and reengineering for increased profits.

Government's Changing Perspective

The private sector is faced with the situation of either rethinking the methods by which business is conducted or facing the indiscriminate, brutal power of the market. While this is true, the public sector is not immune to changes the world is suffering. The attitudinal transformation wrought in industry to compliance with customer desires has spilled over into the government. As Michigan Congressman John Conyers, Jr. expressed, "No longer can we tolerate a structure, culture, and lack of leadership that allows waste and mismanagement to dominate the Federal agencies" (Congressional Committee

on Government Operations, 1993). Today's United States taxpayer is clamoring for the same level of service from government that one would find in the private sector while demanding lower taxes. This translates into what may be the largest bureaucracy in the world, the U.S. government, attempting to entirely revamp the fundamental methods it uses to conduct business.

Great inroads exist for government business process reform in all of its branches. Savings to the taxpayer, however, are achieved in a more politically expedient manner by increasing the effectiveness of those areas which receive discretionary funding. The DoD represented 16% of the United States government's annual budget and 48% of its discretionary spending capability in fiscal year 1997 (D'Angelo, 1996). By definition, discretionary spending is controllable through the appropriations process and the level of this spending can be modified without passing a law (Collender, 1996:180). The DoD is entirely funded by discretionary moneys, consequently there exists great political flexibility to rapidly shift funds from defense capability to tax cuts. Thus, defense has received much of the attention in the U.S. government's quest for efficiency.

DoD's Role

To modify government business methods, like a private sector company, the DoD must first decide what its role will be. "Prior to 1990, the Cold War defense policy required the US military to simultaneously support a global war and at least one major regional conflict" (Bollinger and Davila-Martinez, 1996:2-1). Since the fall of the only other superpower nation, the U.S. has seen an era

of force reduction designed to align the amount of military force structure with the existing potential threat. "The forces the Administration fields today are sufficient, in concert with regional allies, to defeat aggression in two nearly simultaneous major regional conflicts" (MRCs) (A National Security Strategy of Engagement and Enlargement, 1996:14). Not only is the DoD attempting to downsize in reaction to the reduced threat but, the DoD is also under pressure, like the rest of the U.S. government, to become more economically efficient. This is recognized in the armed services' document, Joint Vision 2010: "The American people will continue to expect us to win in any engagement, but they will also expect us to be more efficient in protecting lives and resources while accomplishing the mission successfully" (Joint Vision 2010, 1997:8).

Air Force Core Competencies

As one of the four entities contributing to the service of DoD's market, the United States Air Force has determined that its role should be one of "defending the United States through the control and exploitation of air and space" ("Mission," 1997). The Air Force has identified six specific core competencies to aid in accomplishing this mission:

Air and Space Superiority

Global Attack

Rapid Global Mobility

Precision Engagement

Information Superiority

Agile Combat Support

(Global Engagement: A Vision for the 21st Century Air Force, 1997:4). As any corporate slogan, these core competencies constitute ineffective rhetoric, without an understanding of their implemented effects.

The typical Air Force activity is not the conversion of raw materials and component parts into salable finished goods. Simply put, the armed services are not manufacturing firms producing a product for consumption by a paying customer. Rather, the DoD is an entity providing a "common good", national defense, within the constraints of a dynamic global political and economic environment. To meet its two near-simultaneous MRC strategy, the Air Force has not needed to pursue, at least to as great an extent as the private sector, the innovations in production management. Rather, it has skipped to cost reduction techniques--most of which are focused primarily on central logistics functions. "Central logistics includes maintenance activities, the management of materials, operation of supply systems, communications, and minor construction" (Hinchman, 1997:15). These activities include aircraft flightline, backshop, and depot maintenance units, ground transportation squadrons and aerial ports, supply squadrons, communication squadrons, and civil engineering units.

Air Force central logistics expenditures for fiscal year 1995 totaled $4.2 billion (Department of Defense, July 1996:7) while DoD's "total budget for operations and support activities in FY 1996 amount[ed] to approximately $93 billion" (Department of Defense, July 1996:4).

DoD Outsourcing Outlook

"To meet the challenges of the current environment the Department of Defense has developed three goals with regard to logistics:

- Reduce response time to get the items to the customer faster
- Develop a seamless logistics system to improve related functions that must work together
- Streamline logistics infrastructure to meet reduced manpower and funding targets

...To meet these goals, some have called on the DoD to outsource those functions which are not core competencies" (Thompson, 1996:1-6). The Air Force has risen to this challenge:

> The composition of the future Total Force will change as the nature of air and space power changes. As a result, the Air Force is committed to outsourcing and privatizing many functions now performed internally. The force will be smaller. *Non-operational support functions will increasingly be performed by Air Force civilians or contractors*. Most uniformed personnel will be operators and a greater percentage will be from the Reserve components. (Global Engagement: A Vision for the 21st Century Air Force, 1997:5, emphasis this author)

A more clear and less formal manner of stating the outsourcing objectives of the Air Force came from Lt. Col. Kyle Johnson when he said that the "focus at the staff [Headquarters Air Force Staff] is to outsource whatever cannot be tied to a wartime mission" (Johnson, 1997). This philosophy has affectionately been dubbed "mobilize or privatize" for the simple reason that positions not essential to combat (i.e. mobility designated positions) are targeted for outsourcing. "Like

the best companies and organizations in the United States, DoD has embarked on a systematic and vigorous effort to reduce the cost and improve the performance of its support activities" (Department of Defense, March 1996:1). This journey may entail shedding those functions deemed unnecessary, outsourcing those functions DoD cannot perform as well in-house, and will definitely include improving the operations that remain organic.

"DoD defines outsourcing as the transfer of functions performed in-house to outside providers and privatization as the transfer or sale of government assets to the private sector" (GAO, March 1997:1). As a result of the recommendations by the Commission on Roles and Missions and the Defense Science Board, DoD has made outsourcing and privatization its primary means "to reduce infrastructure and support costs" (GAO, March 1997:1). DoD infrastructure is composed of those functions previously described as central logistics as well as central training, central medical, installation support, central personnel, and central command, control, and communications (GAO, March 1997:1). If the private sector can perform an activity now performed by the government, a competitive commercial market exists for the activity, and outsourcing the activity can be found to result in the best value for the government, the function may be provided by civilian contractors (Department of Defense, March 1996:4).

Outsourcing or privatizing government functions is not a new issue. "The issue of determining which functions should be performed by the private sector and which ones are more appropriately performed by the government first

surfaced following World War I" (Cole and Cole, 1988:11). Since then much research has been done, regarding the subject matter, to identify its pros and cons as well as the appropriate methods that should be employed. A common theme underlying all discussion and research on outsourcing is, if at all possible, private sector companies should be afforded the opportunity to provide the products and services the government needs rather than the government retaining organic capability. Also since World War I there have been numerous occasions when the government has contracted with private organizations for various products and services. What underlies each of those contracts is an equal amount of uncertainty about the effects of outsourcing as exists in today's global political structure.

Outsourcing "How To"

The DoD and the Air Force, aside from the rampant discourse, have decided outsourcing functions not directly related to the warfighting mission is in the best interest of the United States. How it should be done now comes into question. "The government's first and primary concern should be a <u>definable requirement</u>" (Vines, 1992:5). This has been done and such a definable requirement is arguably spelled out in the DoD's Core Competencies listed above. What makes the marching orders so difficult to follow, however, is that most, if not all, of the Core Competencies represent the very logistics and infrastructure functions slated for outsourcing. "Agile Combat Support" can refer only to the logistics processes which support the warfighting mission. Some

would argue that logistics is a core competency for the armed services and therefore the current definition of the DoD's Core Competencies is correct. Admiral Eccles, known as the "father of logistics", defined logistics as one of three of the military's core competencies, along with strategy and tactics (Thompson, 1996:2-6). As such, the hard push toward more outsourcing of logistics functions cuts against the grain of the fundamental framework of the DoD. What is not apparent on the surface is that not all logistics are inherently necessary to meet the requirements of war. It then becomes a leadership issue, from a military standpoint, to determine those functions whose organic existence is not essential to support the military machine. Once this has been accomplished it becomes a management issue, from a cost standpoint, to determine those functions that can be most economically supported by a civilian contractor.

Whether the decision rests with leadership or management "the first step toward expanded outsourcing is to acknowledge those objections to outsourcing that persist and, wherever possible, develop outsourcing strategies explicitly designed to overcome them" (Camm, 1996:ix). From a military leadership perspective battlefield command and control is an absolute necessity. Napoleon once said an army moves on its belly. Control over the army's "belly," or its logistics support, will determine exactly how far and how fast it will move. The ability to direct logistics forces where, when, and in what combination necessary to support combat units engaging an enemy can become the decisive factor in any conflict. Once a function has been turned over to a contractor, absolute

control over that function has been forfeited. This loss of control over functions that directly support every movement of combat forces is the perpetual fear, and the likely downfall, of the armed services of a nation. "While in-house functions may be quick to respond to changes in operations, the contractor may not have resources available to accommodate them (Thompson, 1996:2-6). For this reason, great care must be taken by military leaders to ensure there is no possibility the point of the combat forces spear will miss its mark by shortening the logistics shaft.

Management's Cost Decision

Where it can be decided, from a combat viewpoint, there is no threat to wartime capability, the decision to outsource rests with the manager's ability to realize cost savings. "If a service can be quantified then it can be procured by contract" (Perritt, 1990:20). Unfortunately, there is no definitive claim to either economic gains or losses as a result of outsourcing government functions:

- "Costs for operating and maintaining a station supported by a BOS [Base Operating Support] contract consistently exceed the costs for an equivalent station operated by in house resources" (Snyder, 1995:43).
- "Where accurate cost data has been kept, the majority of contracted functions have saved money from the in-house performance" (Perritt, 1990:20).
- "In fact, the U.S. Army Medical Command's experience with commercial activities studies has shown that it is almost always considerably less

expensive for the military system to provide health services than it is to contract for them" (Woodley, 1996:17).

- With respect to DoD's Household Goods program, "There is a great potential for DoD to reduce costs by privatizing" (Paolucci and Thorpe, 1995:57).
- "...where audited, projected savings have not been achieved; and in some cases work contracted out was more expensive than estimated before privatization" (GAO, March 1997:8).

These few examples demonstrate the inconsistent nature of researchers' views on outsourcing within the DoD. While one report would say "there are numerous...examples of outsourcing's beneficial results," (Department of Defense, March 1996:8) another cites "the federal government spent 114 billion on outsourcing in 1995, but has no idea what savings, if any were realized" (Brandt, 1996:5). This duplicity causes what should be a very quantifiable, objective issue to be reduced to the subjectivity of the researcher.

DoD's Costing Methods

One begins to wonder why there is no consistency to these analyses. A cause for this inconsistency may be that "the current cost accounting system is inadequate and is not structured to capture many costs in a manner that is useable to managers attempting to make efficiency decisions" (Cole and Cole, 1988:77). There are two reasons for poor cost accounting by the DoD. One lies in the fact that DoD has no profit motive to properly account for costs. DoD,

while having services like airlift and aircraft maintenance, which are valuable to the commercial sector, is forbidden to compete with the commercial sector. The other is the fact the DoD "accounting system was built when people had no care about what things cost. They had a war to fight!" (Taylor, 1997). It should be noted that civilian corporations, being sustained by profit, are motivated to measure the costs associated with the performance of any operation and its expected return. Although a significant hindrance to the accurate accounting of costs for the DoD, the poor cost accounting system is very much symptomatic. The root cause is, "for installations there is no stable, definitive guidance on methodology to accurately determine costs" (Brandt, 1996:21). Existing accounting guidance is ambiguous primarily because DoD costing factors and DoD objectives are incongruent. In the private sector equipment is procured and personnel are hired based upon the expected demand for a product or service in a particular market. In DoD personnel are hired and equipment is procured to fight a war. This in many cases leaves DoD with capacity, and associated costs, far in excess of what is required to operate in peacetime with no outside market to which it can sell this excess capacity.

Transfer Pricing

When civilian organizations assign costs to a product or service offered for sale, assuming they are a for profit organization, they include all costs associated with that product or service including overhead and profit margin. The goal with this type of pricing on a product is to achieve the greatest level of

profitability. In the event there is no profit to be found with the provision of a particular good or service, and assuming the firm desires to continue producing that product, the firm must price to at least cover variable costs to survive. If an organizational unit provides a good or service to a customer internal to itself, organizations sometimes choose to have these subunits charge one another for those products or services. This is called transfer pricing. While there are multiple variations on the manner by which firms arrange transfer-pricing, "...ideally, the chosen transfer-pricing method should lead each subunit manager to make optimal decisions for the organization as a whole" (Horngren, 1994:864). The method the firm chooses to price products and services between subunits is not the most important issue, the behavior the firm is attempting to encourage through the use of the method is.

When the DoD assigns costs to a service it is required by the Managerial Cost Accounting Concepts and Standards for the Federal Government to assign the full cost of each operation involved in generating that service (Office of Management and Budget, 1995:3). This method of transfer pricing, full product cost transfer-pricing, causes the indirect or overhead cost of maintaining the excess capacity DoD needs for wartime use to be included in the cost calculations for a particular service. It has been argued, since excess capacity is necessary for the armed services in the case of a contingency, the costs associated with sustaining such capacity have no place in the calculation of transfer prices. Camm and Shulemann report "so long as indirect costs are allocated to the prices of services arbitrarily, truly fixed costs grossly distort

prices" (Camm and Shulemann, 1993:xiii). Thus the DoD's method for determining costs associated with performing certain functions may be inappropriate.

Understanding that DoD's transfer-pricing method may not be appropriate, the proper method must be attained. Accounting Concepts and Applications offers the perspective that "variable costs are most appropriate as the basis for transfer prices when no outside market exists but there is excess capacity" (Skousen et. al, 1996;977). Also, in determining if it is most equitable to purchase from an internal subunit or from an outside source, which is the crux of outsourcing, Rayburn, in Principles of Cost Accounting writes: "Variable cost....This is an appropriate transfer price for guiding top management in deciding whether there should be transfers between the two divisions as long as the total variable costs are less than the outside purchase price of the buying division. This transfer price would be appropriate only if the selling division had excess capacity" (Rayburn, 1986;977). Thus organizations with excess capacity (e.g. the DoD) should price products and services for internal transfer at variable costs. Additionally, in deciding which portions of the armed services' combat support functions should be outsourced, variable cost, rather than full product costs, should be used for comparison with commercial vendors. If a good or service can be produced internally to the DoD at variable cost for less than the cost of procuring it at the market rate, the DoD should not outsource the function.

Focusing on the Behavior

Pricing at variable costs for the DoD would take the ambiguity out of cost comparison between commercial sector firms and DoD units, allowing the services to concentrate on the behavior they desire from their managers. If "the purpose of the Department's initiative is to sustain or improve readiness, generate savings for modernization, and improve the quality and efficiency of support to the warfighters," then improved readiness should be the first effect driven by DoD costing methods (Department of Defense, March 1996:4). With the current full product costing transfer-pricing method, DoD units are automatically at a disadvantage in competing against a private sector firm. Specifically, private firms can price at any price at or above their variable costs to compete for DoD work and the variable costs of the private sector firm will most likely be less than the full product costs of the DoD unit. Unfortunately a private sector firm can lower prices to compete for the DoD contract then, once there is no organic unit in place for the DoD to fall back to, "the contractor will likely provide only what was written in the contract or charge additional fees for changes" (Thompson, 1996:2-6). Ultimately, DoD loses control over the function and pays more for the outsourced function; both contrary to the goals of the government.

"Outsourcing is not a theory based on uncertain assumptions. Experience in DoD and the private sector consistently and unambiguously demonstrates how the competitive forces of outsourcing can generate cost savings and improve performance. One need only glimpse at the operations of our nation's most

successful companies to see the dramatic benefits that they realize through outsourcing and competition" (Department of Defense, March 1996:19). While this may be a general speculation, there is evidence of cost savings in both DoD and the private sector by maintaining functions that are not core competencies in house. Evidence also exists in both the private sector as well as the public sector showing outsourcing provides increased service quality at lower costs.

"Coopers & Lybrand surveyed 428 high-growth companies with revenue of less than $50 million. While 53% of those companies that outsource say they averaged cost savings of 13.9%, 29% say they only broke even, and 4% lost money. The remaining 14% could not determine the result of their outsourcing or didn't answer the question-and 24% plan to terminate their outsourcing agreements" (Caldwell, 1997:1).

As previously mentioned, cost savings are but one aspect which would make outsourcing preferable. The essential impetus for outsourcing in the private sector is the ultimate effect on bottom line profits. Given that private firms are not necessarily realizing cost savings with outsourcing, the DoD focus on outsourcing as a cost saving measure may be overemphasized. What will determine the actualization of cost savings in the DoD will be the appropriate measures to drive the desired behavior in seeking the units most suitable for outsourcing.

Nevertheless, DoD and the Air Force are going to forge ahead with the effort to outsource. As transportation is one of the five components of Air Force logistics (the others being supply, aircraft maintenance, logistics plans, and

contracting), it will bear, and has born in many cases, much of any outsourcing and privatization efforts. Throughout the Air Force there have been and continues to be many ground transportation units that have been seriously considered for outsourcing. In some cases, transportation units have been outsourced in their entirety through the A-76[2] process. More recently there has been a tremendous push to greater utilize commercial freight carriers in the movement of military cargo. Much of this push has been the result of the Air Force's Lean Logistics program. "The major principal of Lean Logistics is the reduction of transportation and repair times, a substitution of velocity of items through resupply for mass of inventory" (O'Malley, 1996:8). To affect this major principal, the Air Force has adopted six thrusts of Lean Logistics. The following two thrusts strike close to the heart of this research:

- "Develop 'just-in-time' logistics so that materiel management and distribution processes are much more responsive while buffer stock and real-time management decision making are greatly reduced; and
- Use managed competition to improve organic and contractor performance, not just on cost, but on a wide range of measures pertinent to lean logistics" (Cohen, et. al, 1994:3-4).

These thrusts are aimed specifically at the reduction in time it takes to move assets from a repair location to an operating unit as well as the use of

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[2] Office of Management and Budget Circular A-76 "established procedures for determining whether commercial activities should be outsourced" (General Accounting Office, 1997:7).

outsourcing as a means to derive improvements in DoD processes. Some of the evidence of the effects of Lean Logistics lies in the following:

- General Services Agency has entered into a contract with FedEx to provide air freight movement for government assets within the continental United States.
- United States Air Forces in Europe (USAFE) is in the process of determining which of the two, the DTS or a commercial air freight carrier, will provide optimal services in the shipment of reparable assets to Spangdahlem AB, Germany.
- The focus of this research: Pacific Air Forces (PACAF) is currently assessing the best transportation method for the movement of reparable assets between Support Center Pacific and Western PACAF installations; those in competition for the business include DTS and commercial carriers that operate in that theater.

While these issues are significant in their potential ramifications to DTS they very well may be overcome by events such as World Wide Express (WWX).

World Wide Express

WWX "is an international express package contract" which is projected to provide door-to-door pickup and delivery, customs clearance, in-transit visibility, predictable transit times, commercial dimensional limits, and the capability to transition to war for the shipment of packages 1 to 150 pounds (Slide Package, 1997:4). This program is designed to provide express commercial air freight

service for the above package sizes and mandates DoD use. WWX is expressly a part of Lean Logistics, as it fits the overall objective of priority transportation in lieu of inventory. WWX is designed to provide an incentive for commercial air freight carriers to enroll in the Civil Reserve Air Fleet which augments military airlift during contingencies. The date for full implementation of this program is uncertain but it will, upon inception, completely circumvent the DTS. From a service perspective WWX should provide greater capability, flexibility, and easier access to priority transportation. No plan has been set forth to reduce the infrastructure associated with the DTS as outsourcing initiatives, such as increased use of commercial air express carriers (WWX), press forward. In other words, the Air Force will continue to possess an operational inventory of cargo aircraft for wartime use even though these aircraft will be utilized less and less as commercial carriers are used more. Therefore, the Air Force will have the sunk costs of a private fleet and will add payments to private firms to the total bill. As was mentioned above, if the variable costs of the private fleet are less than the price of the service procured externally, a firm should use the private fleet. Unfortunately, as a fault of DoD costing methods, WWX will be considered less expensive even though costs are likely to increase. Overall, WWX possibly offers a money losing opportunity to the DoD as an outsourcing initiative.

III. Methodology

Introduction

This chapter outlines the methodology to be used in analyzing delivery times for reparable asset movement to installations in Western PACAF. Initially, this chapter restates the current problem and defines the fundamental objectives underlying this research. Measurement questions that must be answered to meet the objectives and arrive at a thorough answer to the current problem are then presented. From there, a description of the various data samples and the research design to be used for the analysis is provided. The chapter concludes with a description of and statistical tools which are employed to manipulate the above data and answer the measurement questions.

Research Focus

This research analyzes the movement of reparable assets from Support Center Pacific (SCP) to Misawa AB Japan, Yokota AB Japan, Kunsan AB Korea, and Osan AB Korea. The ultimate purpose of this research is to determine; 1) whether mean delivery times between SCP and the above bases is slower than mean delivery times for shipments from the CONUS to those bases and; 2) if commercial express transportation will produce significantly faster mean delivery times than the DTS for shipments between SCP and its customers. As such there are two primary objectives to this analysis:

Objectives

1. Determine whether or not reparable assets are shipped faster to the above mentioned installations from SCP or CONUS repair facilities.
2. Determine if commercial express carriers can provide more expedient transportation of reparable assets from SCP to the above mentioned bases.

To achieve these objectives and thus fully examine the reparable asset pipeline in WESTPAC the following specific measurement questions will be answered:

Measurement Questions

1. What are the current mean delivery times between SCP and WESTPAC installations?
2. What are the current mean delivery times between CONUS depots and WESTPAC?
3. Is there a significant difference between the mean delivery times between CONUS depots and WESTPAC installations and the mean delivery times between SCP and its customers?
4. What mean delivery times can be achieved for shipments between SCP and its customers by using commercial express transportation?
5. Are the mean delivery times achievable through the use of a commercial carrier significantly faster than those of the current process?

Answers to these questions will furnish a sufficient quantitative foundation to address the issue of WESTPAC transportation times as outlined in this study's Problem Statement.

Data Sample and Research Design

"The population consists of the set of all measurements in which the investigator is interested" while "a sample is a subset of measurements selected from the population" (Aczel, 1993:2-3). Given that the interest of this study is in reparable asset shipment duration either from CONUS repair facilities or SCP to SCP customers, the population of measures would consist of *all* such shipments between those locations. Collecting this population of data is both impossible and impractical as such data is nonexistent in many cases. Furthermore, the entire population of measures need not be gathered to derive a reasonable understanding of its behavior. In fact "we use the information in the smaller set of measurements (the sample) to make decisions, predictions, or generalizations about the large or whole set of measurements (the population)" (McClave et. al, 1988: 6). Therefore, to answer the measurement questions outlined above, specific data samples were gathered and particular quantitative techniques were applied to those samples.

Data was gathered for reparable asset shipments from SCP to its Air Force customers from July 1995 through January 1997. This time frame is restricted to the above limits primarily based upon the accuracy and availability of shipment data. Although these shipments by no means constitute the total

population of shipments between the various installations of interest they constitute a reasonable sample. Another sample was gathered for shipments between all appropriate CONUS repair facilities and the same WESTPAC installations for the same time frame.

These first two sets of data were used to achieve the first research objective:

1. Determine whether or not reparable assets are shipped faster to the four WESTPAC installations from SCP or CONUS repair facilities.

To make this determination, the data sets were first manipulated to answer the following two measurement questions:

1. What are the current mean delivery times between SCP and WESTPAC installations?
2. What are the current mean delivery times between CONUS depots and WESTPAC?

A specific process was followed to derive answers to these questions. First, delivery times (measured in days) were calculated for each shipment in each of the two sets of data. The processes specifically noted in Chapter I were used to define delivery time for this research. These delivery times were averaged across the total number of shipments in the data set to provide the mean delivery time for the route between the depot level repair facility (either in the CONUS or SCP) and each installation located in WESTPAC.

From these mean delivery times a comparison of the two pipelines was made to answer the following measurement question:

3. Is there a significant difference between the mean delivery times between CONUS depots and WESTPAC installations and the mean delivery times between SCP and its customers?

This comparison of mean delivery times was conducted using the *z* statistic which will later be discussed in greater detail. Four different tests were conducted, one for each WESTPAC installation, with the following basic hypothesis (specific hypotheses will be discussed below):

$$H_0: (\mu_{CONUS\text{-}WI} - \mu_{SCP\text{-}WI}) = 0$$

$$H_a: (\mu_{CONUS\text{-}WI} - \mu_{SCP\text{-}WI}) > 0$$

In non-mathematical terms the null hypothesis states that there is no difference between the mean delivery time for shipments between the CONUS and a WESTPAC installation (WI) and the mean delivery time for shipments between SCP and the same WESTPAC installation. Of course the alternate hypothesis states simply that there is a difference. This comparison of means will empirically assess the cogency of the assertion which initialized this research; the claim that it takes longer for reparables to move between SCP and its customers as compared to delivery times from CONUS repair facilities.

Particular attention should be given the transportation priority codes assigned to the assets being shipped in these two samples. The data for those shipments being transported from CONUS repair facilities to WESTPAC wings are transportation priority (TP) expedite or TP-1 shipments. This priority is assigned to items having a RDD code of "999, or a Non Mission Capable Supply

(NMCS) or Mission Capable (MICAP) code" (AFI 24-201, 1996:5). In fact, all of the shipments for which data was analyzed had an RDD code of 999. The data for those shipments being transported from SCP to WESTPAC installations are slightly different in that RDD codes 999 as well as shipments with RDD codes of 777 were used. "RDD code 999 identifies shipments having the most urgent need" and such shipments are required to move "to the consignee as fast as possible by traceable means" (AFI 24-201, 1996:5). All of the RDD 999 coded data for shipments from SCP to its customers and some of the RDD coded 777 shipments (specifically those identified as "Lean Logistics/Two-Level Maintenance (LL/2LM)") will travel by the most expedient, traceable means (AFI 24-201, 1996:5). However, some of the SCP to WESTPAC data points used were for TP-2 cargo. This transportation priority "is assigned when the RDD code is 777...or an actual RDD is more than 2 but less than 5 days from the time the shipment is received by Transportation for...intra-theater...destinations" (AFI 24-201, 1996:5). As such, some of the inter-theater shipments will move slower, by virtue of its transportation priority, than that cargo being shipped from the CONUS. This fact will inherently bias the analysis in favor of shipments from the CONUS but the assumption of this author is that there will be sufficient evidence of faster deliveries between SCP and its customers to overcome such bias. A sample of the raw data used for shipments between CONUS and WESTPAC installations is available for review in Appendix A. This sample shows the data for shipments from CONUS to Yokota AB, Japan. A sample of the raw data used for shipments between SCP and its customers is available in Appendix B.

This sample contains the data for shipments between SCP and Kunsan AB, Korea.

With the first research objective achieved with the above analysis the following research objective then was assessed:

2. Determine if commercial express carriers can provide more expedient transportation of reparable assets from SCP to the four WESTPAC bases.

Whereas the first three measurement questions could effectively be answered using existing historical shipment data, the following measurement question used to address the second research objective required a more experimental approach:

4. What mean delivery times can be achieved for shipments between SCP and its customers by using commercial express transportation?

A commercial express carrier (FedEx[3]) was used to move reparable assets between certain WESTPAC installations (Kunsan AB, Korea and Osan AB, Korea) beginning March 1997 and terminating, for experimental purposes, at the end of June 1997. Shipments of items by the commercial carrier were not constrained by any DoD transportation priority system. In fact, for the stated time frame, items of all transportation priorities were moved via the commercial carrier. A delivery time (measured in days) was assigned to each shipment moved by the commercial carrier during these four months. These delivery times

were then averaged across all shipments moved by the commercial carrier during the experimental time period to provide the mean delivery time achievable by using the commercial carrier.

These mean delivery times were then compared to mean delivery times of the DTS using the *z* statistic to answer the following measurement question:

5. Are the mean delivery times achievable through the use of a commercial carrier significantly faster than those of the current process?

The basic hypothesis used follows (specific hypotheses will be discussed later):

$$H_0: (\mu_{DTS\text{-}WI} - \mu_{COMEX\text{-}WI}) = 0$$

$$H_a: (\mu_{DTS\text{-}WI} - \mu_{COMEX\text{-}WI}) > 0$$

Similar to the hypothesis cited above, the null hypothesis in this case simply states that there is no difference between the mean delivery times achievable by using the DTS and the mean delivery times achievable by using the commercial express carrier. The alternative hypothesis in this case states that there is a difference between the mean delivery times achievable by the two different carriers.

Delivery time data for DTS shipments between SCP and Kunsan and Osan Air Bases was not available from March to June 1997. The reason for this is that a commercial carrier was exclusively used to move shipments between

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[3] FedEx was chosen by HQ PACAF for the sake of availability at the time this study was deemed necessary and for no other reason. Although not proven empirically, it is assumed that the specific commercial express carrier employed is of little import as no significant difference will exist in their individual abilities to provide timely deliveries.

these locations during that time period. Therefore, DTS shipment data from March to June 1996 was used. This sample, although from a different year, is sufficiently similar for this analysis.

Given the understanding that there were no *designated* expedited shipments moving on the commercial carrier, a bias in favor of the DTS may exist. This potential for bias is reinforced by the fact that the data for shipments made using the DTS, as previously mentioned, are of a stated high priority. However, regardless of the criticality of the item being shipped, the commercial carrier executes the same process. Thus, no item travels any faster than any other as all shipments are considered *express*. This gives a realistic view of the commercial express carrier's planned use and therefore the expected performance compared to the DTS. Again, this author assumes there is sufficient evidence in favor of the speed of the commercial carrier to overcome any bias in favor of the DTS. The data sample for shipments between SCP and Kunsan AB, Korea via the commercial express carrier is available for review in Appendix C.

Statistical Measurement Tools

Given the objectives and resulting measurement questions of interest as well as the research design which outlines the specific structure of the study, consideration must be given the particular statistical tools to be applied. What are being compared in this study are observations of shipment times to various locations by differing means of transportation. In each case there are shipments

being made to WESTPAC installations from either a CONUS repair facility or SCP. For the first research objective and its corresponding three measurement questions (1, 2, and 3), the comparison is between delivery times from two locations, either a CONUS repair facility or SCP, using DTS assets. For the second research objective and its corresponding measurement questions (4 and 5), the comparison is of the delivery times realized by two different transportation service providers (DTS and the commercial express carrier) over the same route. In either case, there is a comparison of two sets of observations to each other rather than a comparison of a single set of observations to a constant or fixed delivery time. According to Aczel, the most common statistical analysis method employed for such a comparison is the z statistic which is most effective for larger samples (Aczel, 1993: 315). An alpha value of .01 will be used for all tests conducted in this research.

Assumptions. To use the z statistic three assumptions must be met:

> The two samples are <u>randomly selected</u> in an <u>independent</u> manner from the two populations. The sample sizes, n_1 and n_2, are large enough so that $\bar{x}_1$ and $\bar{x}_2$ each have <u>approximately normal sampling distributions</u>. (McClave, et. al, 1994:393)

Given that the sampling is of time series data collected from a process that has been in existence for several years, the time segment of concern in this case is as randomly selected as is possible. Also, the sets of data used for this experiment were collected independently from one another and, in some instances, from processes totally independent of each other. Hence, the assumption of independence is considered satisfied. According to the Central

Limit Theorem "when sampling from a population with mean μ and finite standard deviation σ, the sampling distribution of the sample mean, $\overline{X}$, will tend to a normal distribution with mean μ and standard deviation $\sigma/\sqrt{n}$ as the sample size, *n*, becomes large" (Aczel, 1993: 177). It is widely regarded that, for the Central Limit Theorem to be invoked, the sample must be of 30 observations or more (Aczel, 1993:177 and McClave, et. al, 1988:365). Therefore, before using this analysis tool, an initial assessment of sample sizes must be made. In all cases the data samples for this analysis included more than 30 observations and the *z* statistic was utilized with the following test statistic:

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where,

n_i is the sample size for sample i

s_i is the standard deviation for sample i

$\bar{x}_i$ is the mean for sample i.

However, the data gathered for shipments between SCP and Yokota AB, Japan only entailed 38 observations. Therefore, the Shapiro-Wilk test for normality was used to ensure the process underlying the sample of data is approximately normally distributed.

Hypotheses. Multiple comparisons were made to achieve the objectives outlined in this research. To test the differences between the mean delivery times of the CONUS to WESTPAC pipeline and the SCP to WESTPAC pipeline,

the first step was to test the differences by location. Therefore, the following four hypotheses were used:

1. For shipments to Kunsan AB, Korea;

   H_0: $(\mu_{CONUS\text{-}K} - \mu_{SCP\text{-}K}) = 0$

   H_a: $(\mu_{CONUS\text{-}K} - \mu_{SCP\text{-}K}) > 0$

2. For shipments to Osan AB, Korea;

   H_0: $(\mu_{CONUS\text{-}O} - \mu_{SCP\text{-}O}) = 0$

   H_a: $(\mu_{CONUS\text{-}O} - \mu_{SCP\text{-}O}) > 0$

3. For shipments to Misawa AB, Japan;

   H_0: $(\mu_{CONUS\text{-}M} - \mu_{SCP\text{-}M}) = 0$

   H_a: $(\mu_{CONUS\text{-}M} - \mu_{SCP\text{-}M}) > 0$

4. For shipments to Yokota AB, Japan;

   H_0: $(\mu_{CONUS\text{-}Y} - \mu_{SCP\text{-}Y}) = 0$

   H_a: $(\mu_{CONUS\text{-}Y} - \mu_{SCP\text{-}Y}) > 0$

As can be seen by the above hypotheses, the assumption that no difference exists between the mean delivery times of shipments from the CONUS to WESTPAC locations and those from SCP to WESTPAC locations acted as the null hypothesis (H_0) in each case. This null hypothesis was chosen to reflect the assertion that the DTS provides the same speed of delivery regardless of origin and destination which is assumed to be the status quo. If the null hypothesis can then be rejected it would then follow that there is sufficient evidence to

suggest that there is a significant difference between the mean delivery times of the two routes.

Next, the differences between the mean delivery times achieved by DTS and the mean delivery times achieved by the commercial express carrier were analyzed. These differences were also tested individually by location and the following hypotheses were used:

5. For shipments to Kunsan AB, Korea;

   H_0: $(\mu_{DTS-K} - \mu_{COMEX-K}) = 0$

   H_a: $(\mu_{DTS-K} - \mu_{COMEX-K}) > 0$

6. For shipments to Osan AB, Korea;

   H_0: $(\mu_{DTS-O} - \mu_{COMEX-O}) = 0$

   H_a: $(\mu_{DTS-O} - \mu_{COMEX-O}) > 0$

As can be seen by the above hypotheses, the assumption that there is no difference between the mean delivery times achievable with the DTS as compared to those achievable with a commercial express carrier acted as the null hypothesis (H_0) in each case. If the null hypothesis can then be rejected, the assertion that mean delivery times achievable using a commercial express carrier are significantly different than those achievable using DTS would be found to be supported by empirical evidence.

Chapter Summary

This chapter outlined the research methodology that is to be followed in the conduct of this study. It initially identified the overarching research objectives

that guide the study toward a full analysis of the initial problem; that it is taking reparable assets longer to travel from SCP to WESTPAC installations than it is taking them to be transported from CONUS repair facilities. Next, the specific measurement questions that must be answered to fulfill the outlined objectives were presented. These were followed by a thorough description of the data and statistical tools necessary to perform the measurements. The following chapter will present the analysis and results obtained from the application of this methodology.

IV. Analysis and Results

Introduction

This chapter shows how the results of this research relate to the Problem Statement as presented in the first chapter as well as the research objectives and measurement questions. Restated for the reader:

Problem Statement. This study will determine whether or not the current mean delivery times from SCP to four selected WESTPAC installations is of greater duration than mean delivery times of shipments from CONUS repair facilities. Also, an assessment of PACAF's proposed solution, the use of commercial express transportation rather than the Defense Transportation System (DTS), was made to determine whether or not such a change in operating procedures will reduce mean delivery times.

From this problem statement, two research objectives were derived:

1. Determine whether reparable assets are shipped faster to the four WESTPAC installations from SCP or CONUS repair facilities.
2. Determine if commercial express carriers can provide more expedient transportation of reparable assets from SCP to WESTPAC installations than the DTS.

Assumptions Verification

As was noted in the previous chapter, there are three assumptions that must be verified for the use of the *z* statistic to be valid. The first is the assumption that the data gathered was selected randomly from the population. Given that the sampling is of time series data collected from a process that has been in existence for several years, the time segment of concern in this case is as randomly selected as is possible. The second assumption to be satisfied is that the data gathered is independent. For this research, independence can be assumed as the processes are not dependent on one another. However, the third assumption that the data sets must be large enough to exhibit approximately normally distributed sampling distributions was questionable in the case of shipments made from SCP to Yokota AB, Japan. To alleviate the concern resulting from a relatively small sample size ($n = 38$), the Shapiro-Wilk Test for normality was used to determine if the sample could be considered sufficiently close enough to a normal distribution. A Shapiro-Wilk test statistic of .85 or larger is indicative of a normal distribution. This test resulted in a test statistic value of $T_3 = .9346$ indicating an approximate normal sampling distribution which satisfies the assumptions necessary for use of the *z* statistic.

Hypothesis Tests

Tests of the various hypotheses of concern for this research were conducted using a large sample *z* statistic. The first four of these hypotheses

were expressly designed to provide answers to the following measurement questions:

1. What are the current mean delivery times between SCP and WESTPAC installations?
2. What are the current mean delivery times between CONUS repair facilities and WESTPAC?
3. Is there a significant difference between the mean delivery times between CONUS depots and WESTPAC installations and the mean delivery times between SCP and its customers?

Hypothesis 1. The first hypothesis addressed was a comparison of the mean delivery times between CONUS repair facilities and those of shipments from SCP to Kunsan AB, Korea. It was stated as such:

$$H_0: (\mu_{CONUS\text{-}K} - \mu_{SCP\text{-}K}) = 0$$

$$H_a: (\mu_{CONUS\text{-}K} - \mu_{SCP\text{-}K}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 2 and a z statistic of $z = 8.78$ which causes the null hypothesis to be rejected as the critical value for the z statistic given a .01 level of significance ($\alpha = .01$) is $z = 2.326$. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two routes. By comparing the mean delivery times for the two routes cited in the table below, one can see that the mean delivery time for shipments from the CONUS is larger than the mean

delivery time for shipments from SCP. In other words, items can be more quickly transported to Kunsan AB, Korea from SCP than from the CONUS.

Table 2: Hypothesis 1 Statistics

Mean from CONUS (days)	11.9867
Mean from SCP (days)	6.2859
Variance from CONUS	766.4196
Variance from SCP	9.5911
Sample Size from CONUS	1876
Sample Size from SCP	738
Z statistic	8.7804

Hypothesis 2. The next hypothesis compared the mean delivery times of shipments between CONUS repair facilities and Osan AB, Korea and shipments from SCP to the same location. It was stated as such:

$$H_0: (\mu_{CONUS\text{-}O} - \mu_{SCP\text{-}O}) = 0$$

$$H_a: (\mu_{CONUS\text{-}O} - \mu_{SCP\text{-}O}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 3 and a z statistic of z = 11.30 which causes the null hypothesis to be rejected as the critical value for the z statistic given a .01 level of significance (α = :01) is z = 2.326. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two routes. By comparing the mean delivery times for the two routes cited in the table below, one can see that the mean delivery time for shipments from the CONUS is larger than the mean delivery time for shipments from SCP. In other words, items can be more quickly transported to Osan AB, Korea from SCP than from the CONUS.

Table 3: Hypothesis 2 Statistics

Mean from CONUS (days)	11.5087
Mean from SCP (days)	5.7347
Variance from CONUS	617.9587
Variance from SCP	16.7498
Sample Size from CONUS	2699
Sample Size from SCP	524
Z statistic	11.3036

Hypothesis 3. Next, the mean delivery times between CONUS repair facilities and those of shipments from SCP to Misawa AB, Japan were compared. The hypothesis for this comparison follows:

$$H_0: (\mu_{CONUS-M} - \mu_{SCP-M}) = 0$$

$$H_a: (\mu_{CONUS-M} - \mu_{SCP-M}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 4 and a *z* statistic of $z = 9.33$ which causes the null hypothesis to be rejected as the critical value for the *z* statistic given a .01 level of significance ($\alpha = .01$) is $z = 2.326$. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two routes. By comparing the mean delivery times for the two routes cited in the table below, one can see that the mean delivery time for shipments from the CONUS is larger than the mean delivery time for shipments from SCP. In other words, items can be more quickly transported to Misawa AB, Japan from SCP than from the CONUS.

Table 4: Hypothesis 3 Statistics

Mean from CONUS (days)	11.9454
Mean from SCP (days)	5.6683
Variance from CONUS	729.0841
Variance from SCP	12.1737
Sample Size from CONUS	1723
Sample Size from SCP	413
Z statistic	9.3303

Hypothesis 4. The final hypothesis that was tested to answer the first three measurement questions entailed a comparison of mean delivery times between CONUS repair facilities and those of shipments from SCP to Yokota AB, Japan. The hypothesis for this comparison follows:

$$H_0: (\mu_{CONUS\text{-}Y} - \mu_{SCP\text{-}Y}) = 0$$

$$H_a: (\mu_{CONUS\text{-}Y} - \mu_{SCP\text{-}Y}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 5 and a *z* statistic of $z = 5.81$ which causes the null hypothesis to be rejected as the critical value for the *z* statistic given a .01 level of significance ($\alpha = .01$) is $z = 2.326$. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two routes. By comparing the mean delivery times for the two routes cited in the table below, one can see that the mean delivery time for shipments from the CONUS is larger than the mean delivery time for shipments from SCP. In other words, items can be more quickly transported to Yokota AB, Japan from SCP than from the CONUS.

Table 5: Hypothesis 4 Statistics

Mean from CONUS (days)	11.5546
Mean from SCP (days)	5.4211
Variance from CONUS	951.6805
Variance from SCP	7.3855
Sample Size from CONUS	1035
Sample Size from SCP	38
Z statistic	5.8116

Recalling the first three measurement questions, one is able to see how each of them were answered by the above analysis. Specifically, mean delivery times for shipments between SCP and WESTPAC locations ranged from five to six days. Also, mean delivery times for shipments between CONUS repair facilities and WESTPAC locations was approximately 12 days. As such, the tables provide the current mean delivery times between SCP and WESTPAC installations as well as current mean delivery times between CONUS repair facilities and WESTPAC installations thus answering the first two measurement questions. The hypothesis testing discussed above answers the third measurement question of concern. Specifically, for every installation in WESTPAC, the evidence and analysis overwhelmingly proves that it takes a significantly greater amount of time to transport reparable assets from CONUS repair facilities to WESTPAC than it takes to transport the same items from SCP.

The next two hypothesis tests that were conducted were designed to answer the final two measurement questions restated below:

4. What mean delivery times can be achieved for shipments between SCP and its customers by using commercial express transportation?

5. Are the mean delivery times achievable through the use of a commercial carrier significantly better than those of the current process?

For this set of measurement questions the comparisons made were between the capabilities of a commercial express freight carrier and the DTS.

Hypothesis 5. The first analysis was a comparison of commercial express' mean delivery time to Kunsan AB, Korea with that mean delivery time achieved by the DTS. The hypothesis for this comparison is:

$$H_0: (\mu_{DTS\text{-}K} - \mu_{COMEX\text{-}K}) = 0$$

$$H_a: (\mu_{DTS\text{-}K} - \mu_{COMEX\text{-}K}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 6 and a *z* statistic of $z = 6.024$ which causes the null hypothesis to be rejected as the critical value for the *z* statistic given a .01 level of significance ($\alpha = .01$) is $z = 2.326$. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two carriers. By comparing the mean delivery times for the two carriers cited in the table below, one can see that the mean delivery time for shipments using DTS is larger than the mean delivery time for shipments using the commercial express carrier. In other words, items can be more quickly transported to Kunsan AB, Korea using a commercial carrier than by using the DTS.

Table 6: Hypothesis 5 Statistics

Mean with DTS (days)	5.1561
Mean with FedEx (days)	3.5964
Variance with DTS	4.9581
Variance with FedEx	6.3701
Sample Size with DTS	173
Sample Size with FedEx	166
Z statistic	6.0241

Hypothesis 6. The next analysis was a comparison of commercial express' mean delivery time to Osan AB, Korea with that mean delivery time achieved by the DTS. The hypothesis for this comparison is:

$$H_0: (\mu_{DTS\text{-}O} - \mu_{COMEX\text{-}O}) = 0$$

$$H_a: (\mu_{DTS\text{-}O} - \mu_{COMEX\text{-}O}) > 0$$

Analysis of the sample provided the sample statistics shown in Table 7 and a z statistic of $z = 4.174$ which causes the null hypothesis to be rejected as the critical value for the z statistic given a .01 level of significance ($\alpha = .01$) is $z = 2.326$. This indicates that there is sufficient evidence to believe that there is a significant difference between the delivery times of the two carriers. By comparing the mean delivery times for the two carriers cited in the table below, one can see that the mean delivery time for shipments using DTS is larger than the mean delivery time for shipments using the commercial express carrier. In other words, items can be more quickly transported to Osan AB, Korea using a commercial carrier than by using the DTS.

Table 7: Hypothesis 6 Statistics

Mean with DTS (days)	4.1346
Mean with FedEx (days)	2.8276
Variance with DTS	4.6613
Variance with FedEx	4.6317
Sample Size with DTS	104
Sample Size with FedEx	87
Z statistic	4.1739

From the above discussion and calculations one can see how the final two measurement questions have been answered. The two tables shown above provide the mean delivery times associated with using a commercial express air freight carrier to two of SCP's customers. Specifically it takes approximately 3 to 3.5 days on average to transport items to Osan and Kunsan Air Bases using commercial express transportation. These results provide the solution to the fourth measurement question. Finally, the results from the hypotheses tested listed above give one a clear indication of the answer to the fifth and final measurement question. Both hypotheses tested lend support to the assertion that a commercial express carrier can achieve significantly faster delivery times than the DTS. The commercial express carrier outperforms the DTS from the standpoint of mean delivery time by approximately 1.5 days.

Additional Analysis

Upon assessment of the data analysis above, it was apparent that the variances associated with shipments of reparables from CONUS repair facilities are amazingly large. Therefore, a histogram analysis of the data samples

associated with shipments to each individual WESTPAC installation was conducted. The actual histograms of the data are available in Appendix D. From these histograms it was easy to see that the vast majority of the shipments (80% to 90% in all cases) had delivery times which fell within a narrow range (from 0 to 16 days). Outside of this range, there was a comparatively small percentage of delivery times that were of much higher duration. Given the high transportation priority assigned to these shipments, any delivery time greater than 16 days (in the longest case) was assumed by this author to be an outlier. Each data set was truncated to remove these outliers and *z* tests were conducted on the remaining data.

New Hypotheses. The second comparison of mean delivery times between CONUS repair facilities and those of shipments from SCP to Kunsan AB, Korea yielded the following statistical results:

Table 8: New Hypothesis: Kunsan

Percentage of Data Used	92.06%
Mean from CONUS (days)	7.9334
Mean from SCP (days)	6.2859
Variance from CONUS	7.1630
Variance from SCP	9.5911
Sample Size from CONUS	1727
Sample Size from SCP	738
Z statistic	12.5827
*No shipment delivery times greater than 16 days were used in this test.	

Three specific points should be gleaned from the above table. First, the variance associated with shipments from the CONUS was reduced from 766.4196 to

7.1630; a reduction of greater than two orders of magnitude. Next, it should be noted that 92.06% of the shipments were used to make these calculations. This point, coupled with the first point should point to the fact that there was a very small percentage of shipments that had very large delivery times thus severely skewing the total data. Finally, the *z* statistic value for this test should be noted. From the initial test the *z* statistic came to be 8.7804 which indicated that there was a significant difference between the mean delivery times for shipments from the CONUS to Kunsan and mean delivery times for shipments from SCP to Kunsan. The *z* statistic with the modified data set was 12.5827 which further reinforces the initial analysis.

From the following two tables one can see that similar results were found for shipments to Osan AB, Korea and Misawa AB, Japan:

Table 9: New Hypothesis: Osan

Percentage of the Data Used	90.59%
Mean from CONUS (days)	7.3595
Mean from SCP (days)	5.7347
Variance from CONUS	6.6485
Variance from SCP	16.75
Sample Size from CONUS	2445
Sample Size from SCP	524
Z statistic	8.7242
*No shipment delivery times greater than 14 days were used in this test.	

Table 10: New Hypothesis: Misawa

Percentage of the Data Used	82.94%
Mean from CONUS (days)	7.1819
Mean from SCP (days)	5.6683
Variance from CONUS	4.4501
Variance from SCP	12.174
Sample Size from CONUS	1429
Sample Size from SCP	413
Z statistic	8.3847
*No shipment delivery times greater than 11 days were used in this test.	

The analysis performed with modified data for Yokota AB, Japan did not however produce a *z* statistic value that reaffirmed the initial analysis. A possible explanation for this phenomena is the fact that, for shipments between SCP and Yokota, there were only 38 shipments for which data was available. As a result,

there may have not been sufficient evidence to conclude that there was a significant difference between the two routes. The following table summarizes the analysis for shipments going to Yokota AB, Japan:

Table 11: New Hypothesis: Yokota

Percentage of Data Used	89.76%
Mean from CONUS (days)	6.23251
Mean from SCP (days)	5.42105
Variance from CONUS	4.06442
Variance from SCP	7.38549
Sample Size from CONUS	929
Sample Size from SCP	38
Z statistic	1.82026
*No shipment delivery times greater than 11 days were used in this test.	

This additional analysis attempted to determine what the effect would be if the data were manipulated in such a fashion as to remove perceived outliers and thus reduce the overall variance in the samples. It was found that almost exactly the same results were provided by the modified data sets as provided by the raw data. No attempt was made to explain the large variances associated with the raw data samples nor was there an attempt to explain why the data points removed from the samples were considered outliers. These particular tasks will be left for additional research by the interested parties. While this additional analysis involved the filtering of suspected outliers from the data sets for shipments between the CONUS repair facilities and WESTPAC installations no filtering was performed on the data sets for shipments from SCP to the WESTPAC installations. As there is only approximately 1.5 days separating the

mean delivery time achievable from the CONUS and that achievable from SCP such filtering of the other data sets is warranted. This filtering may in fact enlarge the gap between these two mean delivery times. This task should be conducted in conjunction with further research.

Chapter Summary

This chapter has provided the reader with an analysis of the results of this research using the methodology prescribed in the previous chapter. The focus has been on how the actual hypothesis tests conducted resulted in solutions to the measurement questions outlined initially in the first chapter. Additionally, validation of the assumptions involved with conducting the specific hypothesis tests was outlined. These results show the following:

- Mean delivery times for shipments between SCP and WESTPAC locations ranged from five to six days
- Mean delivery times for shipments between CONUS repair facilities and WESTPAC locations was approximately 12 days
- It takes a significantly greater amount of time to transport reparable assets from CONUS repair facilities to WESTPAC than it takes to transport the same items from SCP
- It takes approximately 3 to 3.5 days on average to transport items to Osan and Kunsan Air Bases using commercial express transportation
- The commercial express carrier outperforms the DTS from the standpoint of mean delivery time by approximately 1.5 days

Specific results of each test's calculations conducted using Microsoft Excel were summarized in both narrative as well as tabular format. Additional analyses were conducted to determine the effects on the hypothesis tests if the CONUS to WESTPAC data sets were manipulated to separate perceived outliers thereby reducing sample variance. These analyses provided almost identical statistical results as that of the initial analysis but with significantly reduced sample variance. The final chapter of this research will furnish conclusions that this author has drawn from this research as well as recommendations for additional research.

V. Conclusions and Recommendations

Introduction

This chapter reviews the course of this research, draws conclusions from this research, and provides direction for other researchers on this particular subject. The chapter reviews the purpose of the study and will continue forward with a description of the findings from the analysis conducted. The practical ramifications of the findings will then be shared and the chapter will conclude with recommendations for further study.

Research Review

This research was spawned by a concern from upper level PACAF leadership that intra-theater transportation was not providing an appropriate level of service. Specifically, the HQ PACAF/LG, Brigadier General Jenkins, argued that it was taking a longer amount of time to transport reparable assets between Support Center Pacific (SCP), a regional repair facility located at Kadena AB, Japan, and its customers than it was taking to move reparables between CONUS repair facilities and the same customers. What makes this assertion so discomfiting is the fact that SCP was specifically designed and maintained with the understanding that it was to provide increased service to its customers for critical items. Slow transportation of those assets between SCP and its customers could, in effect, render the augmented repair capacity SCP offers

relatively ineffective. What confounded the problem further was the appearance that reparable assets were moving from the CONUS in less time. Such a situation could cause PACAF leadership to reconsider the necessity of SCP.

Under the assumption that it was taking a greater amount of time to ship assets to WESTPAC installations from SCP as compared to shipments from the CONUS, PACAF leadership offered a suggested solution to the problem. As is becoming more and more prevalent in the U.S. armed services, the suggested solution was to utilize a commercial express air freight carrier to move critical assets from SCP to its customers. The underlying assumption with this method of transport was that it would take the commercial carrier significantly less time to move the items between the two locations. To begin the analysis by providing test data of a commercial carrier's capabilities to move the critical assets, the services of FedEx were enlisted.

The HQ PACAF/LGT, Colonel Wang, felt that thorough analysis of both delivery times between CONUS repair facilities and WESTPAC installations as well as delivery times from SCP to those same locations would adequately resolve the question of whether or not items were traveling from CONUS faster than from SCP. Furthermore, a comparison of the capabilities of the DTS and those of a commercial carrier should be conducted. This would give an indication of the level of service available through each method of transport and would show whether or not commercial express transportation would be an avenue of pursuit appropriate for solving the problem of slow government transportation. These comparisons were performed using Microsoft's Excel

version 7.0 to conduct large sample statistical analyses. The hypotheses used in all cases involved a comparison of means and entailed utilizing the z test statistic.

Research Objectives and Results

There were two main objectives to this research:

1. Determine whether or not reparable assets are shipped faster to WESTPAC installations from SCP or CONUS repair facilities.
2. Determine if commercial express carriers can provide more expedient transportation of reparable assets from SCP to WESTPAC installations.

By using several months of reparable asset shipment data for both shipments between CONUS repair facilities and WESTPAC installations and SCP and those same installations the first objective was achieved. Comparing mean shipment times for these two transportation methods to Kunsan AB, Korea, Osan AB, Korea, Yokota AB, Japan, and Misawa AB, Japan it was found that there was not sufficient evidence to prove it was taking longer to transport items from SCP when compared to CONUS. In fact, there was evidence suggesting exactly the opposite was true, that it was taking a longer amount of time to move assets from CONUS to WESTPAC installations than it was taking to move them from SCP.

Although it can be seen by this research that items are transported more quickly between SCP and WESTPAC locations than they can from the CONUS,

one can assert that there is still room for improvement. To this end, the services of FedEx were compared to those delivery times achievable by the DTS. Comparisons of mean delivery times between Kunsan and Osan Air Bases located in Korea and SCP located at Kadena AB, Japan were conducted. The comparisons showed that there was indeed a significant difference between the services rendered by the commercial carrier and those of the DTS. Specifically, evidence was found that supported the notion that a commercial carrier would provide more rapid transport of assets between the above locations which effectively addresses the second objective of this research.

Conclusions and Management Concerns

What PACAF leadership can draw from this research are the conclusions that 1) intra-theater government transportation outperforms that of transportation from the CONUS with respect to delivery time and 2) commercial express air freight carriers offer an avenue of additional delivery capability within WESTPAC superior to that offered by the intra-theater DTS. This research also presents additional management implications in the form of questions the PACAF leadership must consider:

- How can delivery times between Support Center Pacific and its customers be improved?
- Do the costs associated with utilizing a commercial express air freight carrier suit the benefits gained?

- What caused the large variances associated with the initial analysis?

Another interesting aspect of the data analysis refers to the variances associated with intra-theater shipments via the DTS as compared to the commercial carrier. In the case of shipments to Kunsan AB, Korea, although the mean was greater, the variance of the DTS was much smaller than that of the commercial carrier indicating a more predictable (reliable) delivery time. In the case of shipments to Osan AB, Korea, the variances for the two carriers were roughly equal although the mean delivery time for the DTS was statistically significantly greater. Rather than answer specific management questions this research has narrowed the field of analysis and pointed more closely at those implications as areas that could benefit from additional research.

Recommendations for Further Research

To more adequately analyze the entire problem associated with reducing transportation times within WESTPAC this research has identified the following areas needing additional attention:

Outlier and Variance Assessment. As was cited in Chapter IV, shipments from the CONUS experience large variance in their delivery times. This is due to the few shipments that individually experience very long delivery times skewing the total data set. A better understanding of these outliers is recommended at least from the standpoint of determining what caused such huge delivery times. This analysis may indicate areas in the delivery process or specific assets that need particular attention to enable delivery times to improve.

Costs of Commercial Transportation. This research has pointed to the two most prevalent costs associated with utilizing contracted services rather than those available organically, namely fiscal cost and loss of control. In the most general sense, shipping rates are negotiable between the contracting agency and the contractor. As such, a true cost analysis can be performed to assess the commercial carrier options available and their individual rate structures. This should provide PACAF with an understanding of the fiscal constraints of utilizing this option. With respect to transportation costs, leadership should keep in mind that organic assets, like commercial express carriers, are but one of the many avenues available for moving parts and people.

What is more nebulous but quite possibly more important in the business of national defense is the cost associated with the loss of control over the assets being delivered by a commercial carrier rather than organic transportation. Leadership must consider the loss of control over the reparable asset delivery in light of the approximately 1.5 day decrease in delivery time. Being a qualitative assessment, a cost benefit analysis would be difficult to conduct and would therefore demand that its conclusions be drawn by the agencies responsible for its implementation.

Bottleneck Analysis. This research took the broad perspective of analyzing the actual carriers' capabilities over their routes. Processing times associated with moving a reparable through the each step in the delivery process were not considered. Rather, delivery times in this study took a broad systems perspective, by defining the system in Chapter I and not analyzing the detailed

steps within that set system. As such, the individual times involved with moving the piece from the maintenance work center to supply, processing it through supply, processing it through packing and crating, processing through the aerial port of debarkation, and then reprocessing through the various work centers at the receiving location were not delimited. An analysis which breaks the total pipeline into segments could pinpoint the particular step which takes the most time, in other words, the bottleneck. A follow-on analysis of the means by which the process identified as the bottleneck may be improved should also be performed.

Route Optimization. The comparison between the DTS and the commercial express carrier revealed faster transportation is available with the commercial carrier. As the comparison was conducted by analyzing shipments to only two locations, it would seem that the operations of the commercial carrier should not be significantly different than those of the DTS. The actual difference indicates that there is a great potential for organic transportation to improve its operations to such an extent to allow for *at least* as rapid service as the commercial carrier. "At least" is emphasized because the obvious way to improve organic operations would be to duplicate those of the commercial carrier therefore recreating the same transportation capability. However, there may be avenues for performance improvements with organic transportation assets that are not available to the commercial sector. Given this, a thorough analysis of the DTS channel mission structure within WESTPAC is advisable. This study should be geared toward optimizing the WESTPAC channel mission schedule by

subordinating all processes to the most expedient delivery of reparable assets from SCP.

Total Reparable Asset Pipeline Analysis. One of the important management considerations that should be further studied is the effectiveness of the entire reparable asset pipeline. A comparison of the responsiveness of the CONUS repair facilities with regard to every step in the entire pipeline (all six steps outlined in Chapter I) with the same measures made using data from SCP should be made. Given that there is only approximately 1.5 days separating the mean delivery time of shipments from the CONUS repair facilities to WESTPAC locations from the mean delivery time of shipments from SCP to WESTPAC installations (after the outliers had been discarded) this analysis becomes crucial. This assessment should not only be limited to responsiveness as measured by time it takes to repair and return a reparable asset, but also the total inventory cost associated with the number of reparables needed to fill each pipeline.

Commercial Carrier Analysis. Understanding that a commercial carrier is one of many viable options, an investigation should be conducted to determine if a commercial carrier will provide adequate capability, specifically addressing the assets for which the carrier will be needed to provide service. Furthermore, meticulous examination of the effects of moving to the use of that express commercial carrier, from the standpoint of mission accomplishment, must be conducted. Additionally, thorough understanding of the current transportation

channel structure may provide valuable insight into its possible reengineering to derive a more effective method of transporting reparable assets.

In addition to an examination of the commercial carrier as a potential source of transport service for reparables within WESTPAC, a thorough knowledge of the environment in which such a carrier will be operating holds no less importance. Understanding the ramifications of trade relations between nations has become more important today as global trade becomes the norm rather than the exception. While trade environment is important when transportation modifications must be made there must first be a force which would make modification of existing operations necessary. For this reason, this research would determine, from the standpoint of mean delivery time, if there is a compelling reason for PACAF to move from its current transportation method to another.

Thesis Summary

Transportation, particularly rapid global transportation, has not only become possible with today's technology but it has also become the norm and standard. This increased speed and reach of transportation has enabled agencies on one side of the planet to compete with agencies on the other side on a more equal footing. Even the United States government is not immune to the effects of these changes in transportation.

In this day of reductions in force structure, the U.S. armed services have become more reliant on rapid global transportation. The policy of Global

Engagement the Air Force, and the armed services as a whole, tout with such pride is founded on the premise of small, powerful forces capable of deploying from stations located mostly within the CONUS to any point in the world, engaging an enemy on foreign soil, and being victorious. The key to this mobile force is a transportation infrastructure that will perform such a task on a moment's notice. Knowing that "nothing happens 'til something moves" the U.S. has become more cognizant of the fact that it must structure its transportation forces accordingly. To this end, methods are continuously being sought to decrease the amount of time it takes military forces to be deployed and the amount of logistics involvement necessary to support deployed forces.

In many instances the U.S. government has utilized the capabilities of the private sector to augment or replace existing logistics forces. Reasoning behind this is twofold: 1) the outsourced processes are more efficient and reduce total costs and 2) better service is achieved. These gains are achieved not without cost. While being more efficient, a commercial source for logistics may not actually provide for a total cost savings. Also, even though better service may be achieved there is a loss of government control associated with relying upon sources outside of the DoD. In fact, once the government eliminates its involvement in a particular process it places itself totally at the mercy of that contractor. When conducting a study of any national defense process, these costs must be assessed alongside the prospective benefits while keeping a very long-term view of the nation's national security needs.

Support Center Pacific was founded on the premise that it would provide greatly needed reparable assets to certain installations with greater speed and flexibility than the repair centers located within the continental United States had the capability so to do. Given this, any supporting process that reduces the speed of reparable asset return from SCP effectively destroys the desired additional capability. At a certain point, this chipping away at the capability will make SCP no more effective at its task than any repair facility located elsewhere.

The research conducted during this analysis found that there is an marked advantage, from an asset delivery time standpoint, to having SCP available as a repair source. What deserves further consideration is the notion that, although delivery times between SCP and its customers are faster than those from CONUS repair facilities, SCP delivery times are still not of sufficient speed. Findings from this research suggest that better delivery times may be achieved by using a commercial express air freight carrier. In that light, using the commercial carrier is an *option* to decrease reparable delivery times but possibly only one of several ways to perform that task. It is therefore this author's recommendation that a full analysis of the processes and options available to transport reparables within WESTPAC be conducted. This analysis would best be conducted by incorporating the recommendations for further research cited above at a minimum.

Appendix A
Sample CONUS to WESTPAC Data

Shipments from the CONUS Repair Facility to Kunsan AB, Korea						
SRAN	Requisition Number	NSN	Day Shipped	Day Received	Delivery Time	Priority
5284	FB528460039601	2920011033305	4	11	7	999
5284	FB528460039606	5330008745958	4	11	7	999
5284	FB528460059600	4140008303067	8	11	3	999
5284	FB528460059602	6680010754853	5	10	5	999
5284	FB528460059610	2510010865269	5	11	6	999
5284	FB528460089603	5995011807219	11	16	5	999
5284	FB528460089605	5330012852251	8	12	4	999
5284	FB528460089608	4730011743858	9	16	7	999
5284	FB528460090065	6605013540467	37	44	7	999
5284	FB528460099601	5305008503013	10	16	6	999
5284	FB528460099602	5305011467289	10	16	6	999
5284	FB528460099606	4820011175680	10	16	6	999
5284	FB528460119608	2530011437812	13	19	6	999
5284	FB528460119611	4730001637744	12	19	7	999
5284	FB528460120002	5340013742135EW	12	19	7	999
5284	FB528460120003	4730001637744	12	19	7	999
5284	FB528460129601	5940000824748	16	22	6	999
5284	FB528460129604	5905010592502	13	19	6	999
5284	FB528460129605	5905011464349	13	19	6	999
5284	FB528460129606	5905011395314	13	19	6	999
5284	FB528460129610	5935004564765	15	22	7	999
5284	FB528460169602	5340012588532	18	22	4	999
5284	FB528460179601	5985012575186	18	30	12	999
5284	FB528460179602	5905010645676	19	30	11	999
5284	FB528460179603	2920012989441	18	24	6	999
5284	FB528460189601	6680010754853	19	24	5	999
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5284	FB528460199615	2530011872519	20	30	10	999
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5284	FB528460199620	2530012035746	21	30	9	999
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5284	FB528460239609	5330004982913	24	30	6	999
5284	FB528460239610	1620010569655	23	30	7	999
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5284	FB528460259600	5995000012546	25	31	6	999
5284	FB528460259606	6680011952146	28	36	8	999
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5284	FB528460259609	5930013050302	27	36	9	999
5284	FB528460259612	6220007526018	28	36	8	999
5284	FB528460269600	6105005129225	29	37	8	999
5284	FB528460269603	4820010513489	26	31	5	999
5284	FB528460309600	2925010576993	31	37	6	999
5284	FB528460309602	5985012358743	154	162	8	999
5284	FB528460310155	4820008803454HS	31	38	7	999
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5284	FB528460329603	5999010689542	36	44	8	999
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5284	FB528460399609	5330012739952	42	47	5	999
5284	FB528460399610	5330012743112	42	47	5	999
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5284	FB528460469606	3120012110582	47	58	11	999
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5284	FB528460719606	5310009250459	72	80	8	999
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5284	FB528460789610	5330012052544	79	99	20	999
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5284	FB528460789625	5330011962426	79	86	7	999
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5284	FB528460799612	2530012118620	81	92	11	999
5284	FB528460799613	2520012147452	81	92	11	999
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5284	FB528451949606	5935010219230	199	205	6	999
5284	FB528451950069	6130008839318ZK	195	200	5	999
5284	FB528451959609	6605013540467	199	205	6	999
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5284	FB528451999606	5950004351222	199	205	6	999
5284	FB528451999607	5961011208924	200	205	5	999
5284	FB528451999609	3040011769268	200	207	7	999
5284	FB528451999611	2990013197873	212	219	7	999
5284	FB528452009603	1560012138629SF	201	213	12	999
5284	FB528452019601	5995010893825	210	219	9	999
5284	FB528452019606	5310010463911	203	209	6	999
5284	FB528452019607	2530004497261	202	208	6	999
5284	FB528452019610	5330012795473	203	219	16	999
5284	FB528452029600	5995012222120	209	219	10	999
5284	FB528452029601	5330003057493	202	209	7	999
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5284	FB528452069619	5961010482119	209	213	4	999
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5284	FB528452069621	5961010056614	208	216	8	999
5284	FB528452079610	2530011872519	209	219	10	999
5284	FB528452079611	2590012910971	209	213	4	999
5284	FB528452079614	1560012729633	208	216	8	999
5284	FB528452080225	5865001887152	209	220	11	999
5284	FB528452119601	1730010608927	217	257	40	999
5284	FB528452129602	3040011497445	222	226	4	999
5284	FB528452139601	1560002258039	214	219	5	999
5284	FB528452139602	5840010783268	215	222	7	999
5284	FB528452139603	5961010369666	217	256	39	999
5284	FB528452149601	6605013540467	229	248	19	999
5284	FB528452149604	5998011587424DQ	319	324	5	999
5284	FB528452150533	5310004723617	217	234	17	999
5284	FB528452159612	7025012816144	218	226	8	999
5284	FB528452169608	1560013155115	219	222	3	999
5284	FB528452179500	4730011176398	271	283	12	999
5284	FB528452199504	4730002314013	222	234	12	999
5284	FB528452209602	6150010532972	221	227	6	999
5284	FB528452219604	6605013540467	221	248	27	999
5284	FB528452219605	5995003977685	223	227	4	N1H
5284	FB528452219606	5999012237475	223	235	12	999
5284	FB528452229605	3040009537958	223	227	4	999
5284	FB528452229607	5999003392998	226	268	42	999
5284	FB528452229609	5985010404157	224	235	11	999
5284	FB528452229610	3825011672876	228	258	30	999
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5284	FB528452239612	1680011484167WF	222	241	19	999
5284	FB528452239613	6605013540467	229	248	19	999
5284	FB528452269606	5325010961341	227	235	8	999
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5284	FB528452269612	3110007578328	226	235	9	999
5284	FB528452269614	2910013139304	228	237	9	999
5284	FB528452269615	2510013136114	227	237	10	999
5284	FB528452269617	2510013136113	227	237	10	999
5284	FB528452279603	5330002277600	228	236	8	999
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5284	FB528452369601	9150010842103	241	256	15	999
5284	FB528452399600	1560012645536WF	240	248	8	999
5284	FB528452399601	1560012648606	244	248	4	999
5284	FB528452400012	1005012275986	243	254	11	N1G
5284	FB528452409605	4710010443525	242	248	6	999
5284	FB528452409610	4720010430768	242	248	6	999
5284	FB528452409612	4710012155995	242	248	6	999
5284	FB528452419605	3020005881484	242	248	6	999
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5284	FB528452439611	5920012934130	252	258	6	999
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5284	FB528452439617	6145013543796	249	258	9	999
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5284	FB528452449615	5995012091384	245	254	9	999
5284	FB528452449616	5995012091385EW	244	254	10	999
5284	FB528452449619	5320011478762	247	255	8	999
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5284	FB528452489605	5365010559824SF	262	268	6	999
5284	FB528452489606	5935006543956	250	290	40	999
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5284	FB528452509609	5995003354953	251	258	7	999
5284	FB528452509611	4730010596368	254	262	8	999

5284	FB528452541930	5998011834320EW	255	278	23	999
5284	FB528452549606	5995013489675	307	311	4	999
5284	FB528452549610	1650010423259SF	254	264	10	999
5284	FB528452550251	5970010554720	280	305	25	999
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5284	FB528452569605	3040010559971	258	268	10	999
5284	FB528452569606	3020008938349	257	265	8	999
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5284	FB528452569608	3020010554231	257	269	12	999
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5284	FB528452579613	6140011028970	258	265	7	999
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5284	FB528452610215	5998013027562EW	262	278	16	999
5284	FB528452619607	5315010440080	262	268	6	999
5284	FB528452619609	5310010563239	262	268	6	999
5284	FB528452619611	5310010563238	262	268	6	999
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5284	FB528452630242	4320000620511HS	263	278	15	999
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5284	FB528452630277	1650012289276	263	277	14	999
5284	FB528452639610	6685011809037	265	277	12	999
5284	FB528452639615	6145012032691	264	277	13	999
5284	FB528452639616	2520013828874	264	277	13	999
5284	FB528452649604	1650010423259SF	264	278	14	999
5284	FB528452649628	1005010553370	266	277	11	999
5284	FB528452650151	5955011847924EW	272	339	67	999
5284	FB528452650153	5995012103255	304	310	6	999
5284	FB528452659607	5995011807219	265	279	14	999
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5284	FB528452689607	5945010454807	272	290	18	999
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5284	FB528452699603	4730000074677	272	283	11	999
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5284	FB528452799602	4720010606872	283	289	6	999
5284	FB528452799607	4720010525982	279	291	12	999
5284	FB528452799611	5310011502387	279	289	10	999
5284	FB528452799612	4820008745323	281	289	8	999
5284	FB528452799613	4730011609347	281	289	8	999
5284	FB528452799618	4720013080558	283	289	6	999
5284	FB528452799625	4720010525982	303	303	0	999
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5284	FB528452859612	5320010561565	286	292	6	999
5284	FB528452859617	5320010573796	286	292	6	999
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5284	FB528452869612	5340012170584	290	303	13	999
5284	FB528452899602	1730009484258	290	296	6	999
5284	FB528452899603	2930012565350	325	331	6	999
5284	FB528452900002	5998013027562EW	290	296	6	999
5284	FB528452900255	5998013027562EW	291	303	12	999
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5284	FB528452910284	5955001887043	292	305	13	999
5284	FB528452919601	2520013828728	292	334	42	999
5284	FB528452919607	4710010881069	292	303	11	999
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5284	FB528452939600	6605010580975	294	304	10	999
5284	FB528452939601	6605010182184	294	304	10	999
5284	FB528452939610	6150012676476	342	353	11	999
5284	FB528452969600	4130011255233	298	317	19	999
5284	FB528452979600	5310010510662	298	36	103	999
5284	FB528452979601	5340010434222SF	298	317	19	999
5284	FB528452979602	5305010578141	298	317	19	999
5284	FB528452979608	4730010449090	298	305	7	999
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5284	FB528452979612	6625011249713	299	334	35	999
5284	FB528452979614	5995013535748	297	305	8	999
5284	FB528452989604	3040011082332	301	310	9	999
5284	FB528452989606	1630012173141	300	305	5	999
5284	FB528453009602	5995011829696EW	300	305	5	999
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5284	FB528453049600	4730010939529	305	313	8	999
5284	FB528453049601	4730011694665	305	313	8	999
5284	FB528453049603	1560011067133	305	311	6	999
5284	FB528453059603	5935014184467	12	19	7	N1A
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5284	FB528453079607	5310008281885	308	324	16	999
5284	FB528453079609	5935010588463SF	311	324	13	999
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5284	FB528453119602	6145011149089	312	324	12	999
5284	FB528453129602	5935003528790	313	324	11	999
5284	FB528453179600	5306002378296	318	326	8	999
5284	FB528453189600	9340011517973	321	326	5	999
5284	FB528453199608	5330013577245SF	322	346	24	999
5284	FB528453199609	6625011249713	320	326	6	999
5284	FB528453219606	5995012103252	325	331	6	999
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5284	FB528453249615	3120011674172	324	334	10	999
5284	FB528453249616	5998011307002	324	334	10	999
5284	FB528453250102	2815013160053	333	339	6	999
5284	FB528453259604	4710012589522	325	334	9	999
5284	FB528453259606	5998010772310DQ	336	340	4	NJG
5284	FB528453259607	5998010772310DQ	333	339	6	999
5284	FB528453259611	2910013139281	326	331	5	999
5284	FB528453259613	6625011249713	326	331	5	999
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5284	FB528453269611	5995011886965	329	338	9	999
5284	FB528453269616	3120010456660	329	335	6	999
5284	FB528453310231	5955011847924EW	331	338	7	999
5284	FB528453319607	1560011067133	332	338	6	999
5284	FB528453329603	6680010505837	334	339	5	999
5284	FB528453329606	5930011213097	332	338	6	999
5284	FB528453329610	5935011662939	335	346	11	999
5284	FB528453329613	6685013597914	334	339	5	999
5284	FB528453339612	5995012130755	23	30	7	999
5284	FB528453339613	4720012035424	334	340	6	999
5284	FB528453339614	4720009896479	337	340	3	999
5284	FB528453339615	4720009225136	337	340	3	999
5284	FB528453339616	4730012343260	335	345	10	999
5284	FB528453339618	4720004603915	334	339	5	999
5284	FB528453339621	4310012077027DQ	334	345	11	999
5284	FB528453340106	2610000000182	336	346	10	999
5284	FB528453340107	2610000000182	336	346	10	999
5284	FB528453340128	5985010525959ZW	334	340	6	999
5284	FB528453340129	5985010535913ZW	334	340	6	999
5284	FB528453349600	5985005957066	335	345	10	999
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5284	FB528453349616	5330005313786	340	347	7	999
5284	FB528453350018	6150012676476	345	352	7	999
5284	FB528453389604	6680011181687	340	346	6	999

5284	FB528453399607	4820011560261	340	346	6	999
5284	FB528453399608	4730011731819	340	346	6	999
5284	FB528453399609	4730012831867	340	346	6	999
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5284	FB528453399613	6685010469883	340	346	6	999
5284	FB528453399615	5995013898484	341	353	12	999
5284	FB528453399617	5995013534863	340	346	6	999
5284	FB528453399619	5330000766458	342	346	4	999
5284	FB528453399621	5995013535747	340	346	6	999
5284	FB528453409600	5315010508924	340	346	6	999
5284	FB528453409603	5340011653734	345	361	16	999
5284	FB528453409608	5340011653734	345	352	7	999
5284	FB528453419652	5995012091381	6	11	5	999
5284	FB528453419653	4730004056282	343	352	9	999
5284	FB528453429651	5985012368284	342	352	10	999
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5284	FB528453429654	3010012941043	342	352	10	999
5284	FB528453439600	6110011374061	345	353	8	999
5284	FB528453450153	2530012495547	346	361	15	999
5284	FB528453459602	5995012108463	74	352	278	999
5284	FB528453459608	5365011900817	346	354	8	999
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5284	FB528453469601	5995011886965	347	353	6	999
5284	FB528453470099	5945009028957	349	361	12	999
5284	FB528453479600	5305011903012	347	353	6	999
5284	FB528453479604	5306010992951	347	354	7	999
5284	FB528453479605	5305011010717	349	353	4	999
5284	FB528453479608	4730009286576	348	353	5	999
5284	FB528453479609	4730011464602	348	361	13	999
5284	FB528453479617	5985012052685ZK	348	10	27	999
5284	FB528453479618	5930011760170	349	354	5	999
5284	FB528453489601	6115009255725	349	354	5	999
5284	FB528453489603	4720011424051	352	361	9	999
5284	FB528453520171	4730000548176	353	361	8	999
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5284	FB528453529605	5315011200200	353	361	8	999
5284	FB528453529606	5306010740173	353	361	8	999
5284	FB528453549600	5935002406765	354	361	7	999
5284	FB528453549604	5320010742135	355	361	6	999
5284	FB528453549608	4730000514709	355	361	6	999
5284	FB528453559601	5962012164444	357	3	11	999
5284	FB528453559603	5995011829690	68	73	5	999
5284	FB528453559605	1650011297553WF	24	31	7	999
5284	FB528453559606	3930001534273	356	3	12	999
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5284	FB528453569603	5330011017266	360	3	8	999

5284	FB528453569609	5306002378296	357	3	11	999
5284	FB528453569610	6115009255725	357	9	17	999
5284	FB528453569614	2835010872863	356	8	17	N1A
5284	FB528453610271	5905010571352	362	5	8	999
5284	FB528453619601	5905010571352	362	5	8	999
5284	FB528453619602	5905013741779	363	8	10	999
5284	FB528453619606	6145011010890	363	5	7	999
5284	FB528453639602	1095010659833	116	129	13	999
5284	FB528453639605	1095010659833	116	129	13	999
5284	FM528452402500	4210008892491	249	297	48	999
5284	FM528452642500	6150013822447	275	304	29	999
5284	FM528453101000	8465010490888	313	340	27	999
5284	FM528453101001	8460006068366	317	324	7	999
5284	FM528453101002	6150013822447	313	340	27	999
5284	FM528453321001	7210012860983	336	352	16	999
5284	FM528453461001	6910011947251	348	355	7	999

Appendix B
Sample SCP to WESTPAC Data

Shipments from SCP to Kunsan AB, Korea						
SRAN	Serial Number	Mode	Date Shipped	Date Received	Delivery Time	Remarks
5284	51670063	F	5178	5186	8	999
5284	51750023	F	5177	5179	2	777
5284	50580429	F	5199	5205	6	999
5284	51110152	F	5200	5205	5	NTDIAF
5284	51430386	F	5192	5198	6	NTDIAF
5284	51500256	F	5192	5198	6	NTDIAF
5284	51520231	F	5201	5205	4	999
5284	51530043	F	5208	5213	5	
5284	51670068	F	5187	5191	4	999 D2DY
5284	51720248	F	5199	5205	6	
5284	51730164	F	5193	5199	6	
5284	51740243	F	5200	5205	5	999 D2DY
5284	51860175	F	5195	5199	4	777 D2DY
5284	51870166	F	5188	5191	3	999
5284	51880004	F	5188	5194	6	999
5284	51880009	F	5188	5194	6	
5284	51880019	F	5188	5194	6	777
5284	51880240	F	5191	5199	8	D2DY
5284	51920041	F	5200	5205	5	NTDIAF
5284	51920340	F	5193	5199	6	999
5284	51930114	F	5194	5199	5	D2D TRAVIS
5284	51930179	F	5198	5207	9	
5284	51940025	F	5200	5205	5	999
5284	51940154	F	5195	5199	4	777 D2DY
5284	51940154	F	5195	5199	4	777 D2DY
5284	51950179	F	5198	5207	9	
5284	51950199	F	5198	5207	9	777
5284	51950211	F	5198	5207	9	
5284	51980073	F	5201	5205	4	999
5284	51980074	F	5201	5205	4	999
5284	51980164	F	5209	5213	4	999
5284	51980333	F	5201	5205	4	999
5284	51990073	F	5201	5205	4	999
5284	51990115	F	5201	5207	6	999 D2DY
5284	52000027	F	5207	5213	6	NTDIAF
5284	52060573	F	5208	5213	5	999
5284	52070069	F	5209	5213	4	999
5284	52070321	F	5208	5215	7	999
5284	52070350	F	5208	5215	7	999
5284	51878000	F	5187	5202	15	999
5284	41549611		5221	5233	12	NTD
5284	52370071		5241	5248	7	NTD
5284	42630112		5241	5248	7	NTD
5284	43330021	F	5228	5235	7	777 D3DY
5284	43350230	F	5228	5235	7	999 D3DY
5284	50550020		5241	5248	7	NTD
5284	50550090		5233	5241	8	NTD

5284	50580406		5233	5241	8 NTD
5284	50590232		5233	5241	8 NTD
5284	50600505	F	5241	5248	7 777 D2DY
5284	50650549		5241	5248	7 NTD
5284	50680147		5221	5233	12 NTD
5284	50690209	F	5222	5226	4 999
5284	51160043		5221	5222	1 NTD
5284	51240397	F	5216	5219	3 999
5284	51250211		5221	5233	12 NTD
5284	51430387		5221	5222	1 NTD
5284	51430390	F	5233	5241	8 D4DY
5284	51520215	F	5219	5221	2 999
5284	51600286	F	5226	5233	7 999
5284	51679600	F	5223	5235	12 999 D2DK D5DY
5284	51709612	F	5223	5235	12 999 D2DK D5DY
5284	51719610	F	5226	5235	9 999
5284	51720040	F	5220	5226	6 D2DK
5284	51730199		5227	5235	8 NTD
5284	51740223	F	5227	5233	6 777
5284	51780021	F	5236	5248	12 999 D6DY
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5284	51780400	F	5228	5235	7 999 D2DK D3DY
5284	51790169	F	5233	5241	8 777 D2DY
5284	51800184		5241	5248	7 NTD
5284	51860392	F	5216	5220	4 777
5284	51870138	F	5233	5237	4 777
5284	51870171		5221	5233	12 777 NTD
5284	51880117		5241	5249	8 NTD
5284	51910011		5241	5248	7 NTD
5284	51930015		5227	5235	8 NTD
5284	51930020	F	5234	5241	7 777 D2DY
5284	51930145	F	5234	5237	3 999
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5284	52080042		5234	5235	1 777
5284	52080054	F	5234	5241	7 999
5284	52090141	F	5219	5223	4 777
5284	52090142	F	5233	5241	8 999

5284	52130057	F	5234	5241	7	777 D4DY
5284	52180061		5221	5222	1	NTD
5284	52182421		5221	5222	1	NTD
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5284	52199604		5221	5222	1	NTD
5284	52200039	F	5221	5226	5	777 D2DK
5284	52200045		5221	5241	20	777 NTD
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5284	52218010	F	5221	5234	13	999 D2DK
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5284	52228001	F	5222	5233	11	999
5284	52228002	F	5222	5233	11	999
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5284	52228082	F	5222	5233	11 999
5284	52228089	F	5222	5235	13 999 D2DK D2DY
5284	52228016	F	5222	5233	11 999 D2DY
5284	52228024	F	5222	5233	11 999 D2DK
5284	52228069		5222	5234	12 NTD
5284	52228039		5222	5234	12 NTD
5284	52228092		5222	5234	12 NTD
5284	52228095		5222	5235	13 NTD
5284	52228100		5222	5235	13 NTD
5284	52230208	F	5227	5233	6 777 D3DY
5284	52238002		5223	5235	12 NTD
5284	52238009	F	5223	5235	12 999 D2DK D5DY
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5284	52238037		5223	5235	12 NTD
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5284	52238050		5222	5233	11 NTD
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5284	52260064	F	5227	5233	6 777
5284	52260106	F	5240	5248	8 777
5284	52298000		5226	5235	9 NTD
5284	52268002	F	5226	5235	9 999 D2DY
5284	52338011	F	5233	5241	8 999 D2DY
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5284	52358006	F	5235	5241	6 999
5284	52360007		5241	5248	7 NTD
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5284	52428001	F	5242	5248	6 999
5284	52438001	F	5243	5249	6 999 D3DY
5284	52438003	F	5243	5249	6 999
5284	51230904	F	5256	5261	5 999 D2DY
5284	52568000	F	5256	5262	6
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5284	52448003		5244	5248	4 NTD

5284	52558003		5255	5261	6	NTD
5284	50540506	F	5258	5263	5	999 D2DK D2DY
5284	52060477	F	5249	5256	7	999 D3DY
5284	52080059	F	5254	5261	7	999 D3DK
5284	52080157	F	5251	5254	3	999
5284	52089601	F	5250	5255	5	999 D2DK D3DY
5284	52130045	F	5244	5248	4	999 D2DY
5284	52130052	F	5256	5261	5	999 D2DY
5284	52200004	F	5251	5254	3	999
5284	52410041	F	5257	5265	8	999 D3DK D3DY
5284	52480069	F	5257	5265	8	999 D3DK D3DY
5284	52498002	F	5249	5254	5	777
5284	52508003	F	5250	5262	12	777 D3DK
5284	52518001	F	5251	5262	11	777 D3DK
5284	52518010	F	5251	5262	11	777
5284	52548002	F	5254	5262	8	777 D2DK
5284	52558000	F	5255	5261	6	999 D2DK
5284	52619604	F	5263	5268	5	999 D2DY
5284	52779611	F	5293	5296	3	999
5284	43360309	F	5296	5304	8	999 D6DK
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5284	50950189	F	5291	5292	1	999
5284	51300061	F	5291	5292	1	999
5284	51300067	F	5299	5305	6	999 D2DK
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5284	51520005	F	5296	5304	8	999 D6DK
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5284	51990049	F	5285	5289	4	999
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5284	52410041	F	5283	5285	2	999
5284	52541917	F	5296	5304	8	777 D6DK
5284	52550236	F	5283	5285	2	777
5284	52550239	F	5296	5304	8	777 D6DK
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5284	52710045	F	5296	5304	8	777 D6DK
5284	52868000	F	5285	5289	4	999
5284	52868011	F	5285	5289	4	999
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5284	52918001	F	5291	5303	12	999
5284	52928011	F	5291	5303	12	999
5284	53068005	F	5306	5324	18	999 D5DK
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5284	53128015	F	5312	5324	12	999 D4DK
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5284	53348003	F	5334	5339	5	777 D2DY

5284	53488000		5348	5355	7 NO TRANS DATA
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5284	53380273	F	5355	5362	7 D3DY
5284	53410144	F	5354	5361	7 999
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5284	53538003	F	5353	5354	1 777
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5284	53630083	F	6019	6024	5 777 D3DTS
5284	60040297	F	6019	6024	5 777 D3DTS
5284	60099610	F	6009	6016	7 D2DK D4DTS
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5284	60249605	F	6024	6030	6 D4DTS
5284	60030071	F	6005	6011	6 999 D4DTS
5284	60086017	F	6008	6017	9 999 D8DTS
5284	60088001	F	6008	6017	9 999 D8DTS
5284	60088002	F	6008	6010	2 777
5284	60088003	F	6008	6011	3 999 D2DTS
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5284	60089601	F	6008	6017	9 999 D8DTS
5284	60099604	F	6009	6011	2 999
5284	60119606	F	6011	6016	5 999 D2DY
5284	60248001	F	6024	6030	6 999 D4DTS
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5284	60248013	F	6024	6030	6 999 D4DTS

5284	60248020	F	6024	6030	6 999 D4DTS
5284	53320150	F	6053	6060	7 777 D2DY
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5284	60190002	F	6054	6058	4 999 D2DK
5284	60589601	F	6059	6061	2 999
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5284	60309601		6036	6037	1 999 NTD
5284	50588000	F	6058	6064	6 999
5284	50588005	F	6058	6064	6 999
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5284	50588021	F	6058	6064	6 999
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5284	60320218	F	6054	6060	6 777
5284	60320604	F	6047	6054	7 999 D2DK D3DY
5284	60400266	F	6054	6060	6 777
5284	60430157	F	6054	6060	6 777 D2DK
5284	60468000	F	6047	6051	4 999
5284	60468006	F	6046	6054	8 777 D2DK D4DY
5284	60468009	F	6047	6051	4 999
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5284	60640152	F	6072	6074	2 999
5284	60640152	F	6072	6074	2 999
5284	60650226	F	6073	6080	7 999 D2DK D3DY
5284	60660122	F	6067	6073	6 999
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5284	60660239	F	6067	6073	6	777
5284	60660240	F	6067	6071	4	999 D2DY
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5284	60660276	F	6080	6087	7	999
5284	60660276	F	6080	6087	7	999
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5284	60670203	F	6073	6078	5	999 D2DK D2DY
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5284	60670206	F	6068	6073	5	999 D2DK
5284	60670243	F	6075	6080	5	999 D2DY
5284	60680135	F	6071	6080	9	999
5284	60680195	F	6072	6074	2	999
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5284	60690014	F	6071	6080	9	999 D7DY
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5284	60720217	F	6073	6080	7	777 D2DK
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5284	60740020	F	6075	6080	5	999
5284	60740093	F	6080	6085	5	999
5284	60740192	F	6075	6080	5	777 D2DY
5284	60740195	F	6078	6082	4	777
5284	60750164	F	6078	6085	7	999 D2DY
5284	60750198	F	6088	6093	5	999 D4DK
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5284	60750265	F	6078	6085	7	999
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5284	60750272	F	6082	6086	4	999
5284	60750291	F	6078	6085	7	777 D2DY
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5284	60780151	F	6080	6086	6	777
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5284	60780216	F	6085	6087	2	777
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5284	60800057	F	6081	6087	6	777 D2DK
5284	60800074	F	6085	6093	8	SENT TO SUU
5284	60800136	F	6081	6087	6	777 D2DK
5284	60809607	F	6080	6085	5	777
5284	60809608	F	6080	6082	2	777
5284	60810298	F	6085	6093	8	SENT TO SUU
5284	60810340	F	6085	6099	14	SENT TO SUU
5284	60850163	F	6088	6093	5	999 D4DK
5284	60850191	F	6089	6099	10	777

5284	60850199	F	6088	6093	5	999	D2DK
5284	60860425	F	6088	6106	18	777	D4DK
5284	60870460	F	6088	6093	5	999	D4DK
5284	60870535	F	6088	6093	5	999	D4DK
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5284	60878020	F	6088	6093	5	999	D4DK
5284	60880283	F	6089	6092	3	999	
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5284	60590166	F	6092	6094	2	777	
5284	60670204	F	6120	6122	2	777	
5284	60670238	F	6096	6100	4	777	
5284	60710229	F	6095	6100	5	999	
5284	60750015	F	6094	6099	5	999	
5284	60780223	F	6101	6106	5	999	D2DK
5284	60800003	F	6092	6096	4	999	
5284	60820290	F	6094	6099	5	999	
5284	60820316	F	6092	6096	4	777	
5284	60820322	F	6092	6096	4	999	
5284	60880283	F	6095	6099	4	999	D2DY
5284	60880283	F	6100	6102	2	999	
5284	60890002	F	6092	6099	7	777	D2DK
5284	60890006	F	6092	6099	7	777	D2DK
5284	60890017	F	6103	6106	3	999	
5284	60890053	F	6100	6102	2	777	
5284	60890204	F	6092	6099	7	999	D2DK
5284	60920350	F	6094	6099	5	777	
5284	60930013	F	6094	6099	5	777	
5284	60930022	F	6109	6113	4	999	
5284	60960008	F	6113	6120	7	999	D2DK
5284	60960026	F	6113	6120	7	999	D2DK
5284	60960038	F	6100	6102	2	777	
5284	60960041	F	6107	6114	7	777	D2DK D2
5284	60960073	F	6099	6102	3	999	D2DY
5284	60990023	F	6102	6107	5	777	
5284	60990138	F	6113	6120	7	777	D2DK
5284	60990433	F	6110	6113	3	999	
5284	60990433	F	6106	6108	2	999	
5284	61000012	F	6101	6106	5	777	
5284	61010005	F	6103	6106	3	999	
5284	61010031	F	6121	6123	2	999	
5284	61010031	F	6120	6123	3	999	
5284	61010031	F	6115	6120	5	777	
5284	61010031	F	6113	6120	7	777	
5284	61028000	F	6102	6106	4	999	
5284	61028003	F	6102	6106	4	999	
5284	61028008	F	6102	6106	4	999	
5284	61028011	F	6102	6106	4	999	
5284	61028012	F	6102	6106	4	999	
5284	61028013	F	6102	6106	4	999	

5284	61028015	F	6102	6106	4 999
5284	61029010	F	6102	6106	4 999
5284	61030246	F	6114	6121	7 777
5284	61070018	F	6110	6113	3 999
5284	61070298	F	6108	6114	6 999 D3DY
5284	61070298	F	6110	6114	4 999 D2DY
5284	61070304	F	6108	6114	6 999 D3DY
5284	61070304	F	6117	6122	5 999 D2DK
5284	61070304	F	6121	6122	1 999
5284	61080003	F	6109	6114	5 999 D3DY
5284	61080003	F	6114	6121	7 999
5284	61080092	F	6109	6114	5 999
5284	61080205	F	6117	6123	6 999 D2DK
5284	61080225	F	6109	6114	5 999 D3DY
5284	61100018	F	6113	6120	7 999 D2DY
5284	61109606	F	6110	6113	3 999
5284	61109607	F	6110	6113	3 777
5284	61110034	F	6114	6121	7 777 D2DK
5284	61110039	F	6113	6120	7 999 D2DK
5284	61110049	F	6115	6121	6 999
5284	61120008	F	6114	6121	7 777 D2DK
5284	61140295	F	6115	6120	5 999
5284	61150113	F	6116	6122	6 777 D3DK
5284	61169603	F	6116	6122	6 999 D3DK
5284	51930145	F	6122	6127	5 999
5284	61010031	F	6124	6128	4 999
5284	61010285	F	6151	6153	2 999
5284	61080205	F	6122	6134	12 999 D4DKTMO
5284	61110065	F	6138	6142	4 999
5284	61110065	F	6151	6153	2 999
5284	61120005	F	6123	6128	5 999
5284	61170073	F	6130	6135	5 999
5284	61309607	F	6130	6135	5 999 D2DY
5284	61309608	F	6130	6135	5 999
5284	61379700	F	6137	6143	6 777
5284	61389615	F	6138	6144	6 999 D2DY
5284	60960005	F	6165	6168	3 999 D2DY
5284	61290016	F	6173	6177	4 999
5284	61300343	F	6173	6178	5 999
5284	61490268	F	6173	6177	4 999
5284	61490269	F	6169	6172	3 999 D2DK
5284	61490295	F	6172	6178	6 999 D2DK
5284	61490303	F	6169	6176	7 999 D2DK
5284	61490372	F	6173	6177	4 999
5284	61490373	F	6173	6177	4 999
5284	61510112	F	6164	6169	5 999
5284	61520143	F	6163	6169	6 777 D2DK
5284	61520147	F	6163	6169	6 999 D2DK
5284	61590020	F	6164	6169	5 999

5284	61649601	F	6164	6169	5 999
5284	61649602	F	6164	6169	5 999
5284	61650050	F	6173	6177	4 999
5284	61659610	F	6176	6180	4 999
5284	61669601	F	6166	6171	5 999 D2DK
5284	61989608		6198	6204	6 999 NTD
5284	61280160	F	6180	6184	4 999 D2DK
5284	61700161	F	6192	6197	5 999
5284	61760188	F	6192	6197	5 999
5284	61760189	F	6183	6190	7 999 D2DK
5284	61760236	F	6204	6211	7 999 D2DK
5284	61809601	F	6180	6184	4 999 D2DK
5284	61809602	F	6180	6183	3 999 D2DK
5284	61840020	F	6204	6211	7 999 D2DK
5284	61840045	F	6204	6208	4 777 D2DK
5284	61840800	F	6205	6211	6 999
5284	61850558	F	6192	6194	2 999
5284	61930002	F	6204	6211	7 999 D2DK
5284	61930396	F	6204	6211	7 999 D2DK
5284	61930425	F	6204	6208	4 777 D2DK
5284	61989605	F	6207	6212	5 999 D3DK D3DY
5284	61989605	F	6207	6212	5 999 D3DK D2DY
5284	61989606	F	6201	6205	4 999 D2DK
5284	61989606	F	6201	6205	4 999 D2DK
5284	61989607	F	6200	6205	5 999 D3DK
5284	61999609	F	6199	6205	6 999 D3DK
5284	61999610	F	6205	6212	7 999 D2DK D2DY
5284	61999610	F	6205	6212	7 999 D2DK D2DY
5284	62080154	F	6212	6218	6 999 D3DK
5284	60580516	F	6243	6247	4 999 D2DK
5284	60580517	F	6215	6220	5 999 D2DK
5284	61360092	F	6236	6241	5 999
5284	61840752	F	6218	6225	7 999 D2DTMO
5284	61989605	F	6215	6220	5 999 D2DK
5284	61990225	F	6240	6243	3 999
5284	62050287	F	6240	6243	3 999
5284	62060163	F	6228	6232	4 999
5284	62070006	F	6243	6247	4 999 D2DK
5284	62250394	F	6225	6235	10 999 VIA TRAVIS
5284	62320235	F	6234	6241	7 999 D2DK
5284	62330261	F	6235	6241	6 777
5284	62340003	F	6239	6243	4 999 D2DY
5284	62350011	F	6239	6243	4 999 D2DY
5284	62390151	F	6240	6247	7 999
5284	62420306	F	6243	6247	4 999 D2DK
5284	62619604		6262	6270	8 999 NTD
5284	60870457	F	6250	6255	5 999 D2DK
5284	61280159	F	6253	6260	7 999 D2DK
5284	61490286	F	6247	6250	3 777

5284	61840826	F	6254	6257	3 999
5284	61910382	F	6268	6274	6 999 D2DY
5284	62000010	F	6255	6260	5 777
5284	62000239	F	6255	6260	5 999
5284	62000239	F	6255	6260	5 999
5284	62040031	F	6262	6267	5 999 D2DY
5284	62060163	F	6253	6260	7 999 D2DK
5284	62060170	F	6257	6261	4 999
5284	62080006	F	6262	6267	5 999 D2DK
5284	62080009	F	6267	6274	7 999
5284	62080157	F	6264	6269	5 999 D3DK
5284	62120195	F	6267	6274	7 777 D2DY
5284	62130010	F	6256	6260	4 999 D2DY
5284	62130015	F	6250	6255	5 999 D2DK
5284	62130020	F	6250	6255	5 777 D2DK
5284	62130303	F	6256	6260	4 999
5284	62130303	F	6256	6260	4 999 D2DK
5284	62130304	F	6250	6254	4 999 D2DK
5284	62130304	F	6254	6260	6 999
5284	62190024	F	6250	6255	5 999 D2DK
5284	62200153	F	6255	6260	5 777
5284	62210148	F	6264	6270	6 999 D2DK
5284	62220006	F	6257	6260	3 999 D2DK
5284	62220306	F	6260	6267	7 777 D3DK
5284	62220341	F	6264	6270	6 777 D2DK
5284	62230002	F	6260	6267	7 999 D3DK
5284	62230002	F	6260	6267	7 999 D3DK
5284	62260096	F	6257	6260	3 999 D2DK
5284	62280154	F	6263	6267	4 777 D2DY
5284	62280180	F	6250	6254	4 777 D2DK
5284	62320214	F	6249	6253	4 999
5284	62330181	F	6263	6267	4 999 D2DY
5284	62400025	F	6262	6267	5 999 D2DY
5284	62420115	F	6263	6270	7 999 D4DY
5284	62500150	F	6268	6272	4 999 D2DY
5284	62500528	F	6253	6260	7 999 D2DK
5284	62540305	F	6256	6260	4 999 D3DY
5284	62550263	F	6256	6260	4 999 D3DY
5284	62550264	F	6257	6260	3 999 D2DK
5284	62570033	F	6262	6267	5 999 D2DY
5284	62610128	F	6262	6267	5 999 D2DY
5284	62619605	F	6263	6270	7 999 D4DY
5284	62629601	F	6264	6270	6 999 D2DK D2DY
5284	62690236	F	6270	6277	7 999 D5DK
5284	52490009		6304	6309	5 NTD
5284	52780174		6304	6310	6 NTD
5284	62831234		6283	6287	4 777
5284	62859603		6290	6294	4 999
5284	63040014		6305	6309	4 777

5284	61490269	F	6302	6304	2 999
5284	62250389	F	6285	6289	4 999 D3DK
5284	62250389	F	6305	6309	4 999 D3DK
5284	62340025	F	6303	6304	1 999
5284	62570445	F	6289	6290	1 999
5284	62570461	F	6276	6281	5 777
5284	62570477	F	6298	6303	5 777
5284	62620002	F	6304	6309	5 777
5284	62620215	F	6304	6309	5 777 D2DK
5284	62670007	F	6299	6302	3 777
5284	62780039	F	6304	6307	3 999 D2DK
5284	62780175	F	6283	6289	6 999
5284	62790010	F	6283	6289	6 999
5284	62810270	F	6283	6289	6 999
5284	62830483	F	6284	6290	6 999 D4DK
5284	62830969	F	6305	6310	5 999 D3DK
5284	62831232	F	6284	6290	6 999 D4DK
5284	62831277	F	6284	6290	6 999 D4DK
5284	62840392	F	6285	6290	5 999
5284	62840411	F	6304	6309	5 999 D4DK
5284	62859603	F	6290	6291	1 999
5284	62859611	F	6291	6292	1 999
5284	62859612	F	6291	6292	1 999
5284	62869600	F	6291	6292	1 999
5284	62909605	F	6304	6309	5 999 D4DK
5284	62919608	F	6295	6297	2 999
5284	62920363	F	6295	6297	2 777
5284	62950201	F	6297	6299	2 999
5284	62950228	F	6297	6299	2 777
5284	62960507	F	6299	6305	6 999 D4DK
5284	62990214	F	6302	6304	2 999
5284	63010029	F	6302	6304	2 777
5284	63010030	F	6302	6304	2 777
5284	63010031	F	6302	6304	2 777
5284	63050211		6323	6332	9 777 NTD
5284	63268017		6323	6332	9 NTD
5284	51370023		6310	6313	3 NTD
5284	63268021		6323	6332	9 NTD
5284	63310132		6331	6335	4 999 NTD
5284	60590166	F	6327	6331	4 999 D2DK
5284	60590166	F	6330	6337	7 999 D2DK
5284	60590166	F	6330	6337	7 999 D2DK
5284	60590166	F	6330	6337	7 999 D2DK
5284	62040249	F	6332	6337	5 999
5284	62040249	F	6332	6337	5 999
5284	62250389	F	6323	6326	3 999 D2DK
5284	62250389	F	6323	6326	3 999 D2DK
5284	62640014	F	6332	6337	5 999
5284	62830991	F	6309	6312	3 999

5284	62831018	F	6310	6313	3 999
5284	62840500	F	6309	6313	4 999
5284	62850012	F	6311	6332	21 999 D18DO
5284	62909606	F	6309	6313	4 999
5284	62909606	F	6310	6313	3 999
5284	62909606	F	6311	6316	5 999
5284	62909606	F	6323	6327	4 999
5284	62910013	F	6331	6337	6 999
5284	62950219	F	6320	6323	3 999 D2DK
5284	62950227	F	6310	6313	3 999
5284	62960478	F	6310	6316	6 999
5284	62960478	F	6310	6316	6 999
5284	62980008	F	6310	6313	3 999
5284	63049603	F	6309	6312	3 999
5284	63049604	F	6313	6323	10 999 D4DK D2DY
5284	63050030	F	6312	6316	4 999 D2DY
5284	63050039	F	6310	6313	3 999
5284	63060021	F	6312	6316	4 999
5284	63060070	F	6309	6313	4 999 D2DK
5284	63070003	F	6312	6316	4 999
5284	63090276	F	6311	6313	2 999
5284	63100017	F	6312	6323	11 999 D7DK
5284	63110023	F	6312	6323	11 999 D2DK
5284	63110210	F	6312	6323	11 999 D7DK
5284	63110254	F	6332	6337	5 999
5284	63129602	F	6313	6323	10 999 D5DK
5284	63129607	F	6313	6323	10 999 D6DK
5284	63130134	F	6331	6337	6 999
5284	63130361	F	6317	6323	6 999
5284	63130362	F	6317	6323	6 999
5284	63130374	F	6317	6319	2 999
5284	63160265	F	6323	6331	8 999 D3DK
5284	63190352	F	6323	6331	8 999 D3DK
5284	63190353	F	6330	6337	7 999
5284	63190366	F	6323	6329	6 999 D2DK D3DO
5284	63230085	F	6323	6331	8 999
5284	63268016	F	6323	6332	9 999 D3DY
5284	62909603	F	6351	6357	6 999 D3DK D3DY
5284	62909603	F	6345	6354	9 999 D2DK
5284	62909603	F	6351	6357	6 999 D3DK D3DY
5284	62909603	F	6365	7006	6 999 D3DY
5284	62909630	F	6345	6351	6 999
5284	62980297	F	6337	6344	7 999 D2DK
5284	63110007	F	6337	6341	4 999 D2DK
5284	63130241	F	6362	7003	6 999 D2DK
5284	63210003	F	6353	6358	5 999
5284	63310619	F	6339	6344	5 999
5284	63329632	F	6339	6344	5 999
5284	63329632	F	6340	6344	4 999

5284	63370284	F	6339	6344	5 999
5284	63390403	F	6340	6347	7 999 D4DY
5284	63390404	F	6340	6347	7 999 D4DY
5284	63410222	F	6344	6348	4 999 D2DY
5284	63429602	F	6353	6358	5 999 D2DY
5284	63440430	F	6353	6358	5 999
5284	63450002	F	6345	6353	8 999 D2DK
5284	63460008	F	6345	6353	8 999 D2DY
5284	63460400	F	6345	6351	6 999 D2DY
5284	63460401	F	6345	6355	10 999
5284	63460460	F	6345	6353	8 777 D2DY
5284	63460463	F	6345	6353	8 999
5284	63468800	F	6354	6366	12 999 D3DY
5284	63468805	F	6354	6359	5 999
5284	63468806	F	6354	6359	5 999
5284	63468811	F	6354	6366	12 D3DY
5284	63470539	F	6351	6359	8 999 D3DK D3DY
5284	63470540	F	6365	7006	6 777 D4DK
5284	63470541	F	6354	6362	8 777
5284	63470541	F	6362	7003	6 777 D2DK
5284	63470574	F	6365	7006	6 777 D4DK
5284	63470584	F	6351	6358	7 999 D3DK D3DY
5284	63470589	F	6366	7003	2 999 D3DK
5284	63470589	F	6366	7003	2 999 D3DK
5284	63478001	F	6345	6353	8 999
5284	63510520	F	6351	6362	11 999 D2DY
5284	63510521	F	6351	6362	11 999 D3DK D3DY
5284	63519605	F	6351	6358	7 999 D3DK D3DY
5284	63529609	F	6354	6366	12 999
5284	63530274	F	6354	6366	12 999 D3DY
5284	63540145	F	6358	6362	4 999 D3DY
5284	62570456	F	7003	7009	6 999
5284	63010014	F	7010	7017	7 999 D6DY
5284	63200338	F	7013	7017	4 999 D2DK
5284	63400002	F	7024	7028	4 999
5284	63440415	F	7008	7013	5 999 D2DY
5284	63440415	F	7008	7013	5 999
5284	63460401	F	7006	7008	2 999
5284	63510511	F	7008	7013	5 999 D2DY
5284	63520076	F	7006	7008	2 999
5284	63540146	F	7010	7017	7 999 D6DY
5284	63650106	F	7027	7034	7 999 D2DK D2DY
5284	63660163	F	7003	7006	3 999
5284	70030214	F	7006	7008	2 999
5284	70030317	F	7027	7034	7 999 D2DK D2DY
5284	70060444	F	7030	7035	5 999 D2DY
5284	70080193	F	7009	7015	6 999
5284	70149601	F	7014	7017	3 999
5284	70160295	F	7017	7021	4 999

5284	70210189	F	7024	7028	4 999
5284	70220249	F	7024	7028	4 999
5284	70230173	F	7024	7028	4 999
5284	70240014	F	7029	7034	5 999
5284	70240373	F	7027	7034	7 999 D2DK D2DY

Appendix C
Sample FedEx Data

FedEx Shipments to Kunsan AB, Korea				
Pick Up Day	Number of Pieces	Air Waybill Number	Delivery Day	Delivery Time
7063	2	54982325	7065	4
7064	1	54982712	7069	5
7066	1	54982900	7069	3
7066	1	54982900	7069	3
7066	1	54982911	7069	3
7066	2	54983014	7070	8
7069	1	54983143	7072	3
7070	1	54983331	7073	3
7071	1	54983401	7073	2
7071	2	54983434	7073	4
7072	2	54983655	7076	8
7073	2	54983832	7077	8
7077	2	54970204	7081	8
7077	2	54970215	7081	8
7078	1	54970296	7080	2
7078	1	54970370	7081	3
7079	1	54970414	7080	1
7080	1	54970521	7083	3
7080	1	54970565	7083	3
7080	1	54970635	7084	4
7084	1	54970882	7086	2
7084	1	54970963	7090	6
7085	1	54971103	7090	5
7085	2	54971114	7091	12
7086	1	54971210	7090	4
7087	1	54971534	7090	3
7087	1	54971604	7090	3
7090	1	54971711	7092	2
7091	4	54971836	7094	12
7091	1	54971840	7094	3
7091	1	48496081	7094	3
7092	1	48496221	7097	5
7092	1	48496232	7097	5
7092	2	48496254	7097	10
7093	1	48496313	7097	4
7093	1	48496350	7098	5
7094	1	48496486	7098	4
7097	2	48496556	7100	6
7098	1	48496803	7100	2
7098	2	48496851	7101	6
7099	1	48497002	7104	5
7099	1	48497061	7104	5
7100	1	48497186	7105	5
7105	1	48497514	7107	2
7105	1	48497805	7108	3
7108	1	48498273	7111	3
7109	1	48498306	7113	4

7112	1	48498590	7115	3
7112	2	48498730	7115	6
7113	2	48498763	7115	4
7114	2	48498936	7116	4
7115	1	48499080	7119	4
7115	1	48499220	7119	4
7115	1	48499312	7119	4
7120	1	48499544	7123	3
7123	1	48499684	7136	13
7127	1	49448560	7130	3
7128	1	49448674	7132	4
7129	1	49448836	7133	4
7129	2	49449024	7133	8
7129	1	49449083	7135	6
7133	2	49449422	7136	6
7133	1	49449422	7136	3
7134	1	49449610	7137	3
7134	2	49449621	7137	6
7135	1	49449772	7137	2
7135	1	49449794	7137	2
7135	1	49449794	7137	2
7135	2	49449805	7137	4
7135	1	49449912	7140	5
7136	1	49449982	7140	4
7136	1	49449982	7140	4
7137	1	49450015	7141	4
7140	1	49450166	7142	2
7141	1	49450262	7143	2
7141	1	49450262	7143	2
7142	1	49478726	7147	5
7142	1	49478730	7147	5
7142	1	49478730	7147	5
7143	1	49478752	7147	4
7144	1	49478962	7148	4
7147	1	49478995	7150	3
7148	1	49479080	7150	2
7148	2	49479091	7151	6
7148	1	49479091	7151	3
7149	1	49479334	7151	2
7149	1	49479334	7151	2
7149	1	49479371	7154	5
7149	1	49479382	7154	5
7149	1	49479382	7154	5
7151	2	49479684	7155	8
7151	2	49479883	7155	8
7151	1	49479894	7154	3
7151	1	49479894	7155	4
7155	1	54653325	7160	5
7155	1	54653432	7160	5

7156	1	54653616	7160	4
7157	1	54653830	7161	4
7158	1	54654073	7162	4
7161	2	54654191	7164	6
7161	2	54654224	7164	6
7162	1	54654353	7164	2
7162	2	54654526	7165	6
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7163	1	54654795	7167	4
7164	1	54654946	7167	3
7164	2	54655053	7169	10
7164	2	54655042	7169	10
7165	1	42639181	7169	4
7168	3	42639531	7171	9
7168	2	42639601	7171	6
7169	2	42639671	7171	4
7169	1	42639936	7172	3
7170	2	42640124	7174	8
7170	2	42640264	7175	10
7172	1	42640533	7176	4
7172	1	42640544	7176	4
7175	1	42640990	7178	3
7175	1	83839582	7178	3
7176	1	83839615	7178	2
7176	3	83839766	7181	15
7176	1	83839770	7183	7
7177	1	83839910	7181	4
7177	1	83839965	7182	5
7177	2	83839976	7182	10
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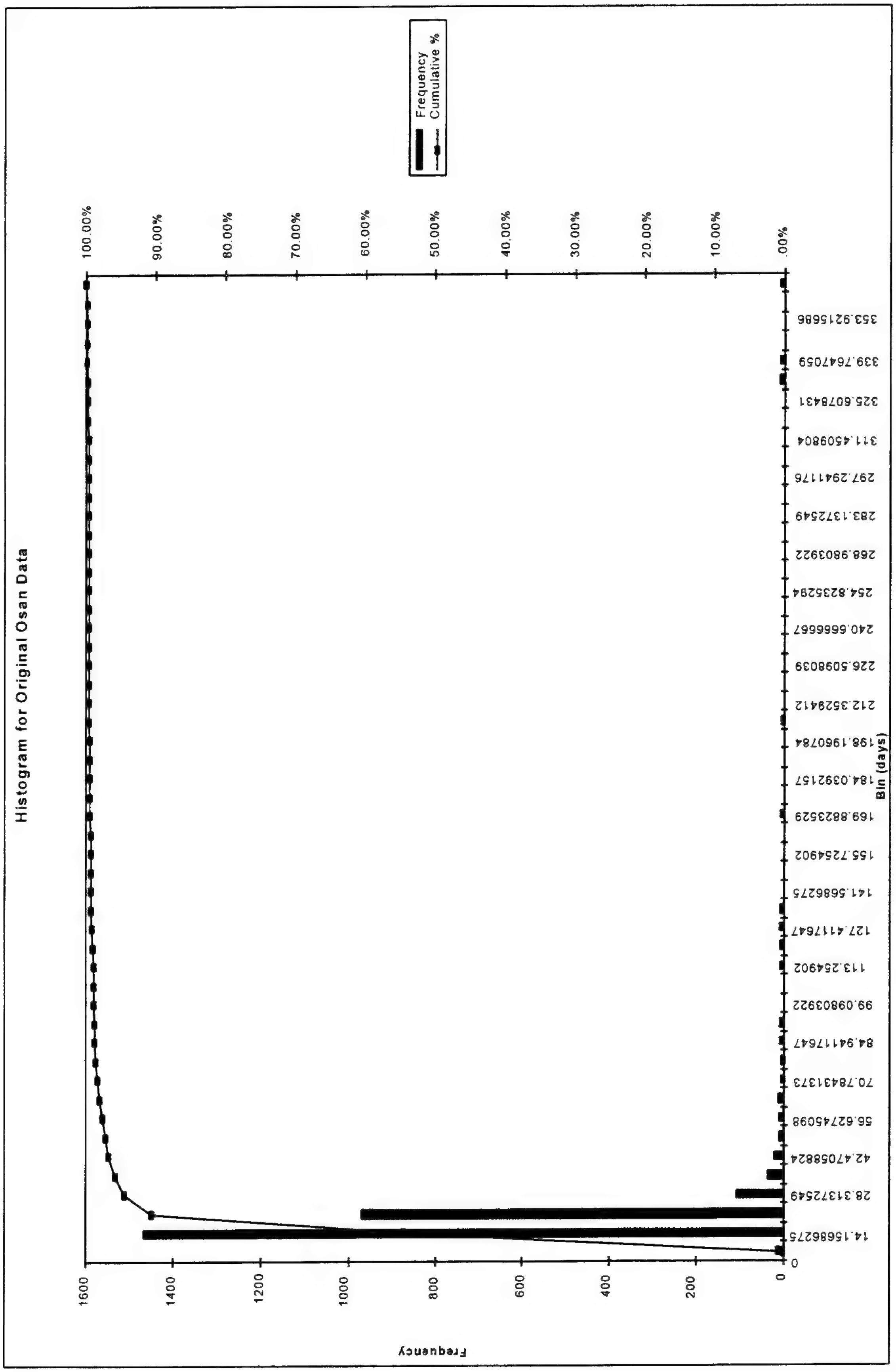
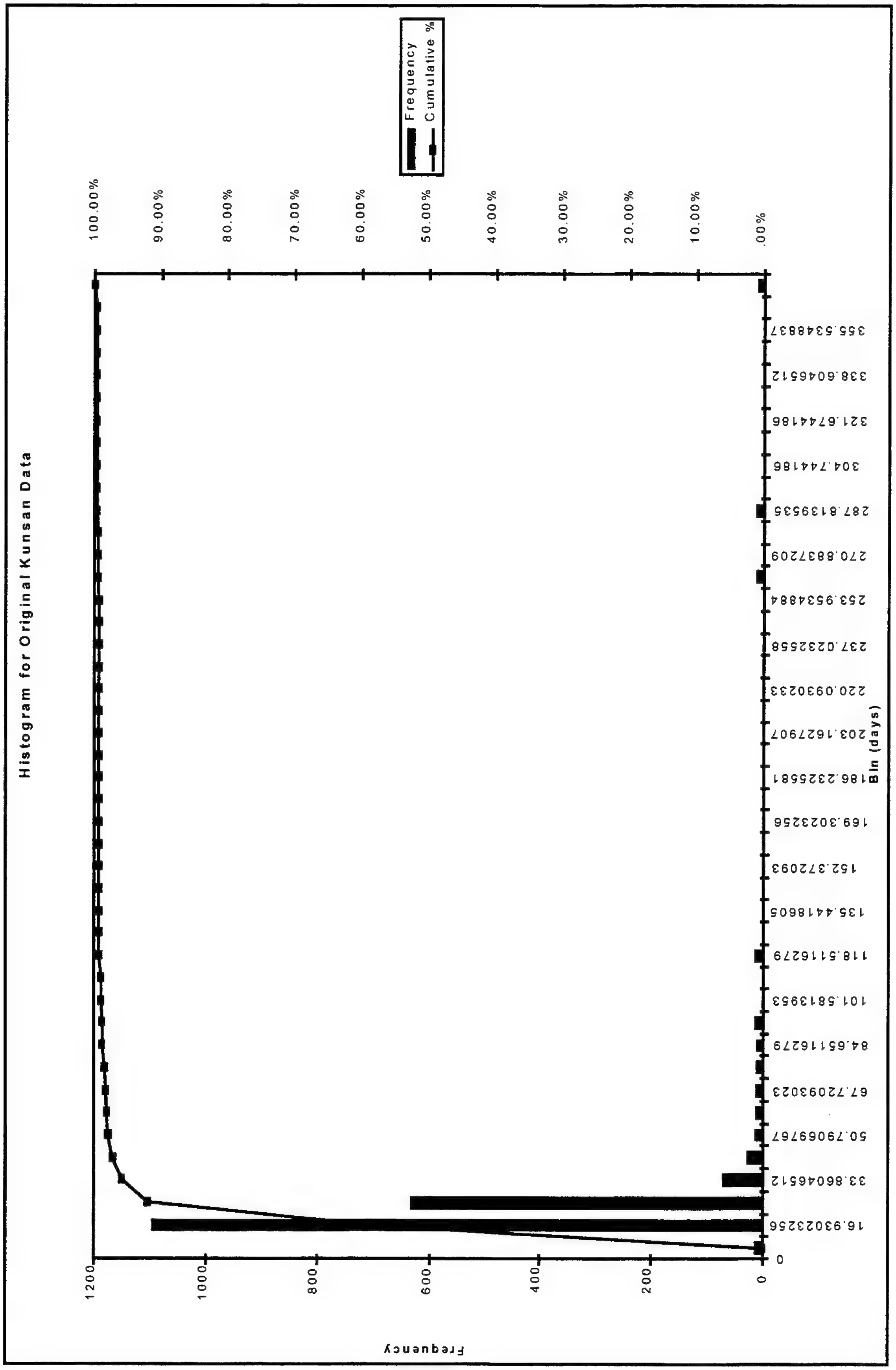
7181	2	83840153	7184	6
7091	1	54971840	7094	3
7091	1	48496081	7094	3
7092	1	48496221	7097	5
7092	1	48496232	7097	5
7092	2	48496254	7097	10
7093	1	48496313	7097	4
7093	1	48496350	7098	5
7094	1	48496486	7098	4
7097	2	48496556	7100	6
7098	1	48496803	7100	2
7098	2	48496851	7101	6
7099	1	48497002	7104	5
7099	1	48497061	7104	5
7100	1	48497186	7105	5
7105	1	48497514	7107	2
7105	1	48497805	7108	3
7108	1	48498273	7111	3
7109	1	48498306	7113	4

Appendix D
CONUS Shipment Data Histograms




Histogram for Original Kunsan Data
Frequency
Cumulative %
1200
1000
800
600
400
200
0
Frequency
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
.00%
0
16.93023256
33.86046512
50.79069767
67.72093023
84.65116279
101.5813953
118.5116279
135.4418605
152.372093
169.3023256
186.2325581
203.1627907
220.0930233
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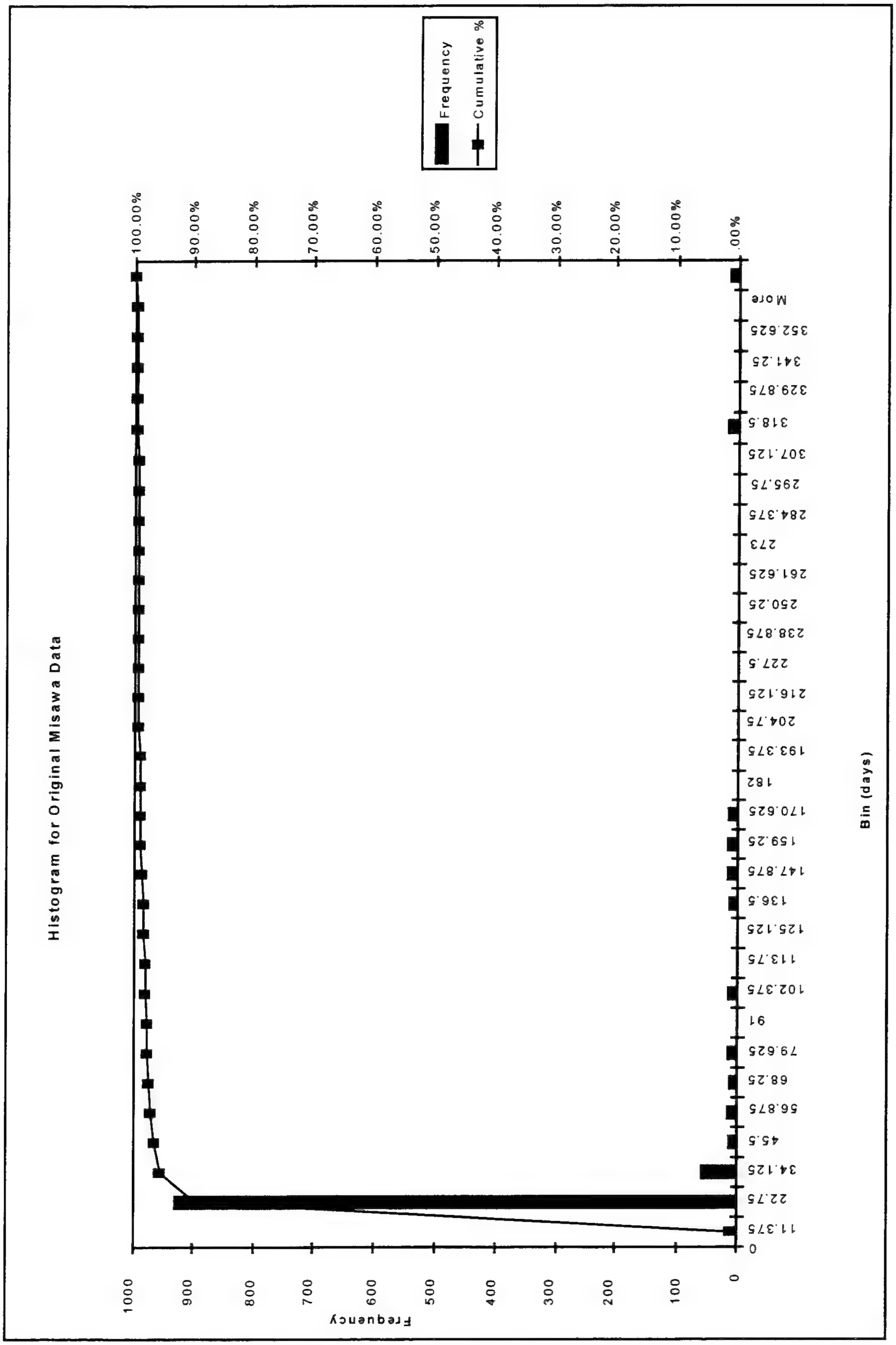
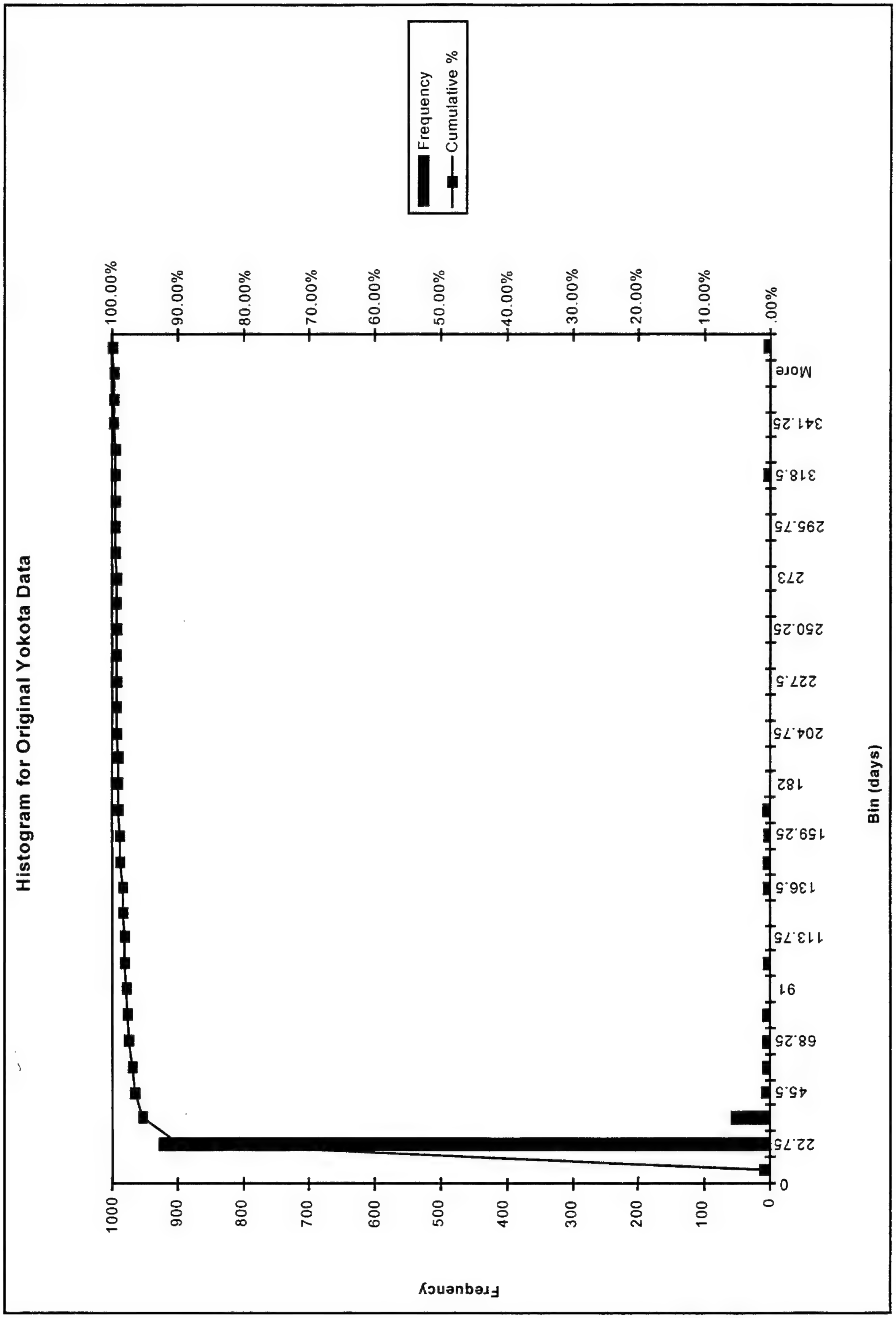
321.6744186
338.6046512
355.5348837
Bin (days)


Histogram for Original Misawa Data
Frequency
Cumulative %
1000
900
800
700
600
500
400
300
200
100
0
Frequency
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
.00%
0
11.375
22.75
34.125
45.5
56.875
68.25
79.625
91
102.375
113.75
125.125
136.5
147.875
159.25
170.625
182
193.375
204.75
216.125
227.5
238.875
250.25
261.625
273
284.375
295.75
307.125
318.5
329.875
341.25
352.625
More
Bin (days)


Histogram for Original Yokota Data
Frequency
Cumulative %
1000
900
800
700
600
500
400
300
200
100
0
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
.00%
0
22.75
45.5
68.25
91
113.75
136.5
159.25
182
204.75
227.5
250.25
273
295.75
318.5
341.25
More
Bin (days)

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Vita

Captain Corey M. Vickers was born on 22 October 1970 in Houston, Texas. He graduated from Jersey Village High School in 1989 and attended the United States Air Force Academy (USAFA) in Colorado Springs, Colorado. He entered USAFA in the summer of 1989 and graduated with a Bachelor of Science degree in Biology in June of 1993. He received his commission on 2 June 1993 and was assigned to the 650th Transportation Squadron at Edwards Air Force Base (AFB) in California. During his tour there he attended Transportation Officer School at Lackland AFB, Texas from which he graduated in December of 1993. During his tour at Edwards, he served as Assistant Chief of Transportation as well as Chief of the Combat Readiness Flight. Additionally, he was selected for a crossflow assignment into the Aircraft Maintenance career field. He graduated as a distinguished graduate from the Aircraft Maintenance Officer's Course (AMOC) at Sheppard AFB, Texas in December of 1994. After AMOC he was assigned to the 412th Component Repair Squadron where he served as the Officer In Charge of the Propulsion Flight.

In May of 1996 he was chosen to attend graduate school at the Air Force Institute of Technology. Captain Vickers graduated from AFIT in September of 1997 with a Master of Science degree in Logistics Management. Afterwards he was assigned to the 86th Transportation Squadron, Ramstein Air Base, Germany as the Combat Readiness Flight Commander.

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13. ABSTRACT (*Maximum 200 Words*)

This study was initiated by the assertion that it was taking a greater amount of time to transport assets from Support Center Pacific (SCP) to its Western Pacific Air Forces (WESTPAC) customers (Misawa AB Japan, Yokota AB Japan, Kunsan AB Korea, and Osan AB Korea) than it was taking to transport similar assets to the same locations from a CONUS repair facility. These delivery times include the total time it takes a reparable asset to be transferred from a repair facility (consignor) to the user (consignee). Pacific Air Forces (PACAF) has proposed using commercial express freight carriers to transport reparable assets between SCP and its customers may reduce the amount of time it takes to move reparables between the WESTPAC locations. Lengthy delivery time severely hampers the most important aspect of having a regional repair facility such as SCP, rapid repair response for key reparable items. Therefore, PACAF became determined to derive delivery times of shorter duration than those achievable from other sources of repair.

This study determines whether or not the current mean delivery times from SCP to WESTPAC installations are of greater duration than mean delivery times of shipments from CONUS repair facilities. Also, an assessment of the use of commercial express transportation rather than the Defense Transportation System (DTS), is made to determine whether or not such a change in operating procedures will reduce average delivery times. Data was collected for shipments between CONUS repair facilities and WESTPAC installations as well as between SCP and the same installations. From these data sets mean delivery times were derived and compared using a large sample z test. Additionally, the means from the samples of data for shipments between SCP and its customers using the DTS were compared to the means from the samples of data collected when a commercial express freight carrier was used using the same test statistic. It was found that, in all cases it took a greater amount of time to move assets between CONUS repair facilities and WESTPAC installations than between SCP and the same installations. It was also found that the commercial express carrier was able to provide a more rapid delivery than the DTS. These findings provide only knowledge about the delivery times associated with these routes and these carriers and should be followed by other analyses.

14. SUBJECT TERMS
PACAF, Transportation, Commercial Express, Defense Transportation System

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